1932.

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA.

IMPERIAL MYCOLOGICAL INSTITUTE
15 MAY 1933

SIXTH ANNUAL REPORT

OF

THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

FOR THE

Year ended 30th June, 1932.

Presented pursuant to Statute, 29th November, 1932; ordered to be printed, 30th November, 1932.

[*Cost of Paper.*—Preparation, not given; 745 copies; approximate cost of printing and publishing, £82.]

Printed and Published for the GOVERNMENT of the COMMONWEALTH of AUSTRALIA by L. F. JOHNSTON, Commonwealth Government Printer, Canberra.

No. 83.—F.4008.—PRICE 3s.

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COMMONWEALTH OF AUSTRALIA.

Council for Scientific and Industrial Research.

SIXTH ANNUAL REPORT FOR YEAR ENDED 30TH JUNE, 1932.

I. SUMMARY OF WORK AND RESULTS.

1. *Introduction.*—The main object of the first part of this report (pages 1 to 10) is to furnish in concise and convenient form a brief review of the principal activities of the Council, and to enable the general reader, who does not wish to concern himself with details, to obtain in a few minutes' time a conspectus of the work which the Council is conducting and of the results already achieved and their economic value. Additional information regarding each of the branches of the Council's work is given in later parts of this report, while detailed results of its investigations are published in the Council's Bulletins, Pamphlets and quarterly Journal. Results of economic value cannot, of course, usually or even generally, be expected to follow from the majority of the Council's investigations within a relatively brief period. As will appear from this report many of the problems on which work has been undertaken are of a difficult and complex character, and it is only as a result of patient and painstaking effort over a period of years that complete or even partial solutions of the problems can be obtained. In some cases the problems are of a relatively simple nature and direct methods of attack can be employed. In most cases, however, a great deal of arduous fundamental work must be undertaken before there can be any hope of obtaining results which can be applied in industry. In spite of these difficulties, as the following records of achievement will show, the Council has made valuable progress in its work, and important results of economic value, far exceeding the total expenditure to date, have already been achieved.

2. *Plant Industry.*—The Council's Division of Plant Industry suffered serous disadvantages in carrying out its work until 1930–31 as it did not possess adequate facilities in the way of laboratories and experimental areas until that year. The Division's Laboratories at Canberra were completed towards the end of 1930, and in the following year a plant house was added, and facilities for experimental plots were obtained at the Duntroon Farm Area in the Federal Capital Territory. It is, therefore, only comparatively recently that this important Division has been at all adequately equipped for the difficult work it is undertaking.

One of the most important activities of the Division is in relation to plant diseases from which it is estimated that Australia suffers an annual loss of no less than £12,000,000. The results of the investigation on bunchy top in bananas, completed a few years ago, and the recommendations made for the control of the disease, have been followed up by the New South Wales and Queensland Departments of Agriculture and by other interests concerned, and the banana industry has now been successfully re-established on large areas in these States.

Confirmatory evidence has been obtained of the relation of bitter pit in apples and immaturity at picking time, and it is now considered that a solution of the problem of the control of bitter pit has been found, and that the annual loss of £100,000 in Australian export apples may be reduced to negligible proportions.

A large amount of valuable information has been obtained by an officer of the Division regarding losses suffered by exporters of Australian apples. Inspection of consignments of apples on arrival in England has shown that bruising is a serious source of loss, both directly as bruising and indirectly as the forerunner of fungal rots and breakdown. An investigation has been commenced on the problem of the prevention of bruising as far as the type of case and method of packing are concerned. Second in importance to bruising as a factor in export apple-marketing is water-core and the related breakdown, and arrangements have been made for investigations to be conducted, with headquarters in Tasmania, on the incidence and control of water-core and cork.

The investigations on blue mould in tobacco, a disease which is so serious a disability to the tobacco-growing industry in Australia, were continued during the year 1931–32, and results having an important bearing on the control of the disease have been obtained.

Valuable progress has been made in the investigations on varieties of wheat resistant to flag smut, which causes an average annual loss of 3 per cent. In some districts losses of 10 per cent. are common, and losses up to 50 per cent. have been known. The object of the Division's work is the breeding of strains of wheat more resistant to flag smut than those at present known. Similarly, investigations are being pursued on footrots, and progress has been made in the work which is being conducted for the purpose of ascertaining the susceptibilities of different varieties of wheat to the disease.

Spotted wilt of tomatoes is another disease which is frequently responsible for the total destruction of plantings. The transmission of the disease has been ascertained definitely to be caused by the bite of a thrips, and thus an important step has been taken towards the ultimate goal of economic control. Valuable progress has already been made in the breeding and disease-resistant varieties of tomatoes.

Confirmatory experiments have been carried out on water blister of pineapples, which causes a loss of £12,500 per annum, and a simple method of control has been devised for commercial application. Investigations are also in progress on certain other plant diseases, including pea diseases in Tasmania and coco-nut diseases in Papua.

An important section of the Division's work is concerned with fundamental investigations on genetics and plant breeding. These investigations are concerned with the mode of inheritance of variations of plant characteristics with a view to facilitating the production of new types. Since wheat is the most widely cultivated crop for export purposes, and since the average yields for Australia are relatively low, the investigations are being concentrated on that cereal with the object of bringing about improvement in quality and yield. A carefully planned trial has been laid down on the Duntroon Farm Area. The Division is not, however, engaged in wheat breeding work along lines similar to those followed by the State Departments of Agriculture.

Another important activity of the Division of Plant Industry is the introduction from abroad of new varieties of plants likely to be of value, particularly in the drier and drought affected areas of the Continent. Close co-operative arrangements have been made with various Institutions abroad, particularly with the Bureau of Plant Industry at Washington, United States of America, for the exchange of plants of economic value, especially of cereals and forage crops. In order to make preliminary investigation of plants suitable for tropical and sub-tropical climates, arrangements have been made for the establishment of a small quarantine area at Gatton Agricultural College, Queensland, and a number of new plants has already been planted at that place. Nearly 3,000 plants have been introduced from 44 different countries. These have all been tried out on the experimental plots of the Division. A number of them is definitely promising and seed of many of these has been sent to State Departments of Agriculture for field trials.

Valuable progress has been made in the work on bud studies in fruit trees. This work is of very considerable practical importance since the adoption of the best methods of cultivation depends essentially on an accurate knowledge of the conditions regarding the development of fruit buds. Valuable work has also been carried out by the Division on a number of other problems including those of fluctuations in apple crops, biometrical studies, seed testing and regeneration of pastures.

3. *Entomology.*—One section of the work of the Council's Division of Economic Entomology is devoted to the entomological control and eradication of weed pests. Satisfactory progress has been made in the investigations on the control of St. John's wort by insect enemies. Following on the discovery by the Council's investigators in Europe of certain species of insects (Chrysomela) which are destructive to St. John's wort, a number of consignments of the insects were sent to Australia and were liberated in selected localities in Victoria and New South Wales after the completion of tests which showed that the insects will not feed on any plants other than St. John's wort. Reports from the localities where the insects were liberated indicate that they have not yet become established and that they suffer severely from attacks of meat ants, ground spiders and other enemies, as well as from the extremely dry summers. Attempts are being made to establish colonies at a higher altitude, and investigations are being continued in England on other insects which attack the plant.

In the United States of America, investigations made by an officer of the Council resulted in the discovery of a fly which attacks the seed pods of Noogoora burr, a weed which already covers thousands of acres in Queensland and which is spreading at an alarming rate. Several consignments of the fly were sent to Australia, and laboratory tests under quarantine showed

that the fly will not attack any plant of economic value. Liberations have accordingly been made in Queensland. Investigations are in progress in the United States of America on a number of other insects which destroy the plant. When adequate supplies of the insects are available, the clearing of large areas of weed infested localities may be rendered possible at a nominal cost, and if this can be achieved the total increase in the value of the land thus made reproductive will amount to millions of pounds.

Another weed pest in regard to which valuable progress has been made is ragwort which covers large areas in the Southern States. Consignments of larvae of the cinnabar moth, which attacks the plant, were obtained from New Zealand and have been liberated on ragwort in South Gippsland. Investigations are also in progress in connexion with the control of bracken fern.

During the year 1930–31 public attention was directed to the menace of the Buffalo-fly pest to the cattle herds of Australia. The Council is not charged with the duty of attempting to control the pest by quarantine measures, &c., but it is investigating the problem with a view to the introduction and distribution of insect parasites and predators which attack the fly at some stage of its life history. The investigations which the Council was conducting in the Netherlands-Indies have now been completed and have resulted not only in a great deal of light being thrown on the problem, but also in the discovery of certain parasites the most effective of which has been introduced into Northern Australia and liberated at a field station at Burnside. If the experiments at that place are successful, the work will be extended to the Gulf country of Queensland. The general conclusion reached as a result of the Council's investigations is that owing to the fact that the presence or absence of the fly is controlled by definite temperature and humidity conditions, south-western Australia, including Perth and Fremantle, is safe from the fly, while in eastern Australia, the fly may be expected to extend only a little south of Rockhampton in Queensland, even if it were not controlled either by parasites or by quarantine measures. The Council is pressing on actively in northern Australia with its work on parasitic control.

Probably no single problem is regarded by Australian primary producers as of equal importance, and no single source of loss as great as that caused by blowfly attack in sheep. Whilst the quest for a means of adequate control of this pest is by no means hopeless, it is admittedly an exceedingly difficult problem. It involves slow and laborious investigations, and where so many able workers have failed in the past it cannot be expected that early spectacular results will follow the investigations which the Council is conducting. Although, therefore, progress must inevitably be slow, already very definite advances have been made in the Council's fundamental work on the problem. For example, accurate knowledge has now been obtained of the habits of the various species of blowfly which attack sheep and definite information has been acquired regarding the species which are " primary ", i.e., which first attack uninjured sheep, and which are, therefore, responsible for the damage, and in the second place regarding those which will only " strike " the sheep after the way has been prepared for them by the attack of " primary " species. It has been established that there is a very definite series of the flies which arrive at successive stages in the process of decomposition. If these species responsible for " primary " strike can be controlled, the problem will be largely solved. During the year 1931–32 a joint Blowfly Committee representative of the Council and of the New South Wales Department of Agriculture was appointed mainly with a view to co-ordinating the activities of those officers of the two organizations who are engaged on the investigation of aspects of the blowfly problem. A comprehensive report surveying the existing knowledge of the problem has been prepared by the Committee and will be published at an early date. Some valuable results have been obtained from the investigations on attractiveness of baits for use in blowfly traps; it has been shown that treatment of ordinary baits, such as liver or " blowfly soup ", with sodium sulphite greatly increases their attractiveness and also their period of activity. Experiments on jetting, traps of various types, carcass destruction and the application of curatives and dressings are also being conducted. Prominence is given to the possibility of partially solving the problem by breeding insusceptible types of sheep.

Investigations on the clover springtail (lucerne flea) in Western Australia have resulted in the discovery of a predatory mite which has been established in the University grounds. Attempts are being made to establish colonies of this mite in localities in Western Australia heavily infested by the clover springtail. Similarily, with respect to the grass-grub which causes such serious damage and loss to pastures, particularly in Tasmania, a parasite has been discovered in New Zealand which destroys a grub closely related to the Australian species. This discovery has opened up a promising line of attack which is being pursued vigorously.

The difficult problem of the control of the apple thrips is being tackled mainly along the lines of investigations on repellents. A Thrips Investigation League has been formed for the purpose of collecting funds which will enable the Council's work on the problem to be intensified in co-operation with the Waite Institute and the State Departments of Agriculture.

In co-operation with the Victorian Apiarists' Association, a research has recently been initiated on a nutritional disease of bees known as the " disappearing trick ", due to deficiency of pollen. It has already been proved as a result of the laboratory investigations that a combination of casein with yeast offers an efficient substitute for pollen. Field experiments will be undertaken next season in order to test the value of the results on a practical scale.

Investigations on pine Chermes, an insect which is proving to be a serious pest of Australian plantations of pines was begun towards the end of 1931. Two promising predatory enemies of the pest have been shipped from England, and a number of one of them has already been liberated. The other will not be liberated as it has been found in the laboratory that it attacks the insects which have been liberated.

Valuable results have also been obtained from the work on the scarab grass-grub which is a serious pest of lawns, greens and pastures. Complete control of this pest has been obtained by use of a lead arsenate spray.

Progress is also being made in the tests which are being carried out on the efficiency of timber preservation processes against the attack of termites.

4. *Animal Health.*—The erection of the McMaster Animal Health Laboratory in the grounds of the University of Sydney has been completed, and the equipment, a certain amount of which was made available by the Department of Veterinary Science of the University, has been installed, and the building was formally handed over to the Council in November, 1931.

The financial assistance rendered under the co-operative scheme with the Empire Marketing Board and the Australian Pastoral Research Trust for the investigation of certain animal (sheep) health problems has been continued. This work, which is being conducted by the Council, includes research into parasitological problems in Queensland, New South Wales and Tasmania, footrot and pizzle disease in Victoria, and pregnancy disease of ewes and pulpy kidney of lambs in Tasmania.

One of the outstanding achievements of the Division of Animal Health is the discovery and practical application of an effective vaccine against black disease of sheep. The economic value of this work will be realized when it is stated that the estimated annual loss from black disease in Australia is no less than £1,000,000 per annum. The Council has been informed authoritatively that the results of this work will lead to a saving of £100,000 per annum in Tasmania alone, with corresponding savings in other States affected. The vaccine evolved by the Council's officers for the prevention of this disease is now extensively used by the Veterinary Divisions of the Departments of Agriculture in Victoria and Tasmania, approximately 150,000 sheep belonging to 150 owners having been vaccinated last year by departmental officers at the special request and expense of the owners. Such vaccinations are in no way compulsory. That the demand increases year by year is the best proof that they are considered of value by those most interested, and is a welcome tribute to the work of the Council's officers. It is reported that in Victoria on properties on which sheep have been treated with the Turner vaccine, the death rate has been reduced from 8 to 0.14 per cent. Similar remarkable results are being obtained in other States. Excellent results have also followed the use of the vaccine devised for the prevention of entero-toxæmia (known as braxy-like or Beverley disease) in sheep in Western Australia. Vaccination is now definitely recommended by the State Department of Agriculture, which undertakes the work.

Pulpy kidney of milk lambs, a disease which is apt to assume serious proportions in flocks the lambs of which are destined for early market, has been investigated in Tasmania and the cause determined to be the same as that of entero-toxæmia.

Internal parasites affecting sheep and cattle have been extensively studied both in the laboratory and at various field stations in Queensland, New South Wales and Victoria with important and interesting results, a number of which has been published. It has been found that the nutrition and general condition of the host has an important bearing on the susceptibility, and results of investigations in progress are very promising. Similarly with regard to caseous lymphadenitis, a disease which causes serious loss in the mutton export trade, work has been pursued actively, and much detailed information has been secured regarding the incidence of the disease, methods of spread under natural conditions, means of prevention, &c. A great deal of work has been done on the production of a satisfactory vaccine, but unfortunately not so far with the success hoped for. With pregnancy paralysis, footrot, pizzle disease, gin gin disease (proved to be a form of ataxia) considerable progress has been made, as well as on a number of other problems of a minor nature.

During the year 1931–32 a laboratory for the investigation of cattle problems in northern Australia was established at Townsville. Maintenance for a period of at least five years is provided conjointly by the Empire Marketing Board, the Queensland Government and the Queensland cattle owners. Active research work commenced in April, 1932. An officer of the Council was commissioned, in accordance with the recommendation of Sir Arnold Theiler, to visit South Africa, and made an extensive study of the method of investigation into tick and other diseases at the famous Onderstepoort Laboratories. Investigations are now actively proceeding on a number of the most important diseases afflicting the northern cattle.

As a result of an extensive visit to United States of America, Canada, Great Britain and New Zealand of an officer of the Council who was awarded a Senior Research Studentship under the Science and Industry Endowment Fund, much valuable information has been acquired regarding the crossing of British breeds of cattle with the Zebu or Brahman cattle, a practice now extensively pursued in the coastal hot areas of United States of America bordering the Gulf of Mexico, and also regarding the pig industry. On both these subjects valuable reports have been published.

5. *Animal Nutrition.*—The work of the Division of Animal Nutrition which is now under the direction of Sir Charles Martin, M.A., D.Sc., F.R.S., has been concentrated almost entirely on a fundamental study of sheep, with a view to building up a body of knowledge which will enable definite guidance and advice to be given to pastoralists so as to enable them to overcome certain serious difficulties with which they are at present faced. The ultimate aim of the investigations is to obtain information whereby sheep living in various localities and climates of Australia may be so fed as to yield the best economic results. The work of the Division may be divided into (*a*) experimental researches in the physiology of nutrition, and (*b*) field investigations, the object of which is to assist the pastoralist to overcome difficulties due to climate or terrain, and to carry on his business to the advantage both of himself and the country. The experimental work in the laboratory and the field investigations are, of course, closely interwoven.

During the year 1931–32, satisfactory progress was made in the investigations which the Division is carrying on under the Australian Pastoral Research Trust-Empire Marketing Board scheme. The object of this work is to determine the best and most economical methods for supplementary and handfeeding of sheep during drought, and for combating the evils attendant on an insufficient amount of phosphorus in the herbage on which sheep are pastured. The work has been facilitated by the completion of an annexe to the Division's Laboratory at Adelaide where experiments on the metabolism of sheep are conducted.

In the laboratory the analysis of grass and other fodder plants is being continued, particularly with reference to their cystine content. The apparent importance of proteins containing, *inter alia*, a good supply of cystine to the sheep, from the point of view of wool production, has been indicated by the results of the field experiments carried out at "Meteor Downs", Queensland. The first two years' experiments at that station showed that it is practicable under certain conditions to obtain an increase of over 30 per cent. in the weight of the fleece at a relatively small cost. A large amount of laboratory work has been carried out on methods for the satisfactory determination of cystine. Special attention has also been given to methods for the estimation of the rate of growth of wool for short experimental periods. Much work has been carried out on the sulphur and phosphorus metabolism of sheep and on the distribution of phosphoric acid in the various parts of the animal. This matter is of practical importance in connexion with experimental work on areas on which these sheep are known or suspected to be suffering from phosphorus deficiency.

Further work has been carried out for the purpose of determining whether a deficiency of iodine exists in pastoral areas in Australia. The results have not given any evidence of such a deficiency, and it is obvious that it is quite unnecessary for pastoralists in the areas investigated to use iodine licks.

An investigation on the basal metabolism of sheep, necessary for estimating the food requirements of sheep, has been completed and the results published. The practical importance of this work lies in the fact that, the basal metabolism being known, the minimum amount of energy-producing food required to keep the animal alive during periods of drought can be determined, and with the data available as to the energy contained in various foodstuffs, their digestibility and their price, the cost of the most economical handfeeding can be determined.

Work has been continued at the various small field stations which have been established in co-operation with several owners of sheep stations and which serve the dual purpose of enabling the results obtained in the laboratory to be tested on a practical scale and, conversely, of drawing the attention of the Council's investigators to practical problems in the field.

Investigations on mineral deficiencies of pastures under the co-operative scheme initiated by the Empire Marketing Board and the University of Adelaide have been continued at the Waite Agricultural Research Institute. The general object of this work is to investigate the mineral content of pastures with a view to determining the grassland areas in which deficiencies exist and the most economical methods of correcting them. The nature of the pastures may be altered profoundly by the use of fertilizers, by the introduction of new pasture plants, and by varying the character of pasture management. Information on these important matters is being accumulated, and since practically the whole of our sheep and cattle are maintained on indigenous pastures, and as in consequence grass must be regarded as Australia's most important crop and her outstanding source of wealth, the significance of these investigations is obvious. Some of the results of the work have already been published.

6. *Soil Investigations.*—The work of the Division of Soil Research has been confined largely to investigations of the soils of the irrigation settlements with the main objects firstly, of advising settlers as to the methods to be adopted in order to make their areas more productive and to minimize the serious troubles with which many of them are faced, and secondly, to make investigations of the soils of virgin areas with a view to future settlement and development, and thus to avoid costly mistakes similar to those which have been made in the past.

Satisfactory progress was made during the year 1931–32 in the work of the Murray River Settlements, and it is anticipated that the whole of that work will be completed in about two years' time. The surveys of the Cadall Settlement, King Island and of a group of Settlements near Swan Hill have all been completed. Preliminary soil maps have been completed of an area of 290 square miles of virgin territory in what is popularly known as the " ninety mile desert " of South Australia.

In the Murrumbidgee Irrigation Area activities have been concentrated on the investigation of water-logging problems. Laboratory work on the rice soils of that area has been continued.

On the completion of the work on King Island arrangements were made with the Tasmanian Department of Agriculture to concentrate on a general survey of the main soil zone of Tasmania, particularly with reference to lime requirements. As there has been much advocacy of the use of lime in that State, it is highly desirable that any extension of its use should have a more rigid scientific basis. The losses incurred in the settlements due to lack of soil investigations in the past, amount to very large sums of money, and the results of the work already carried out by the Council's Division indicate clearly not only that much of the loss could have been avoided had the necessary investigations been made, but also that future developments in irrigation settlements can be undertaken with a full knowledge, so far as suitability of soils is concerned, of the conditions essential for successful production.

In addition to benefiting the settler by furnishing him with authoritative advice as to methods to increase production, the Division has already been able to afford valuable assistance with respect to new settlement projects. An example of this is the investigation of the soils on the bed of Lake Albert, at the mouth of the Lower Murray. As a result of that investigation, it was shown that the project was likely to prove unsuccessful, and it was accordingly abandoned. In this way the saving of a very large sum of money, which would have been wasted, was effected.

7. *Irrigation Settlement Investigations.* The dried fruit industry of Australia has an annual turnover of nearly £3,000,000, and the viticultural and citricultural industries have led to the establishment of thousands of homes in the irrigation areas and to the expenditure of large sums of money on dams, channels, pumping stations, &c. Investigations have been undertaken by the Council on problems relating to dried vine fruits and to citrus fruits, which constitute the main production of these Settlements. For these purposes Research Stations have in the past been established at Merbein and Griffith, respectively.

Since the establishment of the Viticultural Research Station at Merbein the yield of dried fruit per acre has been more than doubled and this increase has been accompanied by a substantial improvement in quality. It may, in fact, be claimed that the present satisfactory condition of the industry is in no small degree due to the results of the Council's work, which results are each year becoming more and more generally applied with consequent improvements in yields, processing methods and quality, and enhanced prices for the products. An outside estimate has assessed the added value of the dried fruit crop at £8 per ton as the result of the work of the Merbein Research Station. During the year 1931–32 special attention was given to further improvement in processing methods and on the keeping qualities of dried fruit, a matter of much importance to the export trade. The methods of drying grapes and sulphuring apricots have been standardized, and commercial results have indicated a greater uniformity and a higher standard in the export pack. Investigations with a view to reducing the unnecessary application of water have been extended and valuable results have been obtained. For example, the work

in the Mildura and Red Cliffs districts has resulted in an estimated saving of no less than £9,000 per annum. A great deal has been done by the Station in co-operation with the Department of Commerce to ensure that the extent of infestation of dried fruit by insect pests is reduced to a minimum. The work of the Station has been materially assisted by a grant from the Australian Dried Fruits Control Board.

Very satisfactory progress has been made in the citricultural investigations at the Council's Research Station at Griffith. The main investigations at the Station concern (*a*) the effect of different soil treatments, yielding capacity and other properties of the soil, (*b*) the most profitable fertilizer treatment for citrus fruit and (*c*) the effect on soil and citrus trees of various methods of green manuring. The experiments have shown that citrus yields can be profitably increased by the adoption of certain cultural and manurial methods. These methods are now becoming the standard practice on the area, with a consequent increase in productivity and reduction in cost.

8. *Forest Products.*—During the year 1931–32 very definite progress was made by the Division of Forest Products towards the solution of some of the many problems which are being investigated. The Division has succeeded in establishing close contact with timber organizations and individual millers, who have shown confidence in its work, and are now freely using its services. The policy adopted by the Division of devoting a large part of its activities to the application of existing knowledge with a view to the immediate improvement of the timber industries, and to the solution of pressing practical problems, has continued to be successful, and is the basis of the confidence now placed by the industries concerned in the work of the Division. Commonwealth and State Government Departments and other public bodies, as well as associations of sawmillers and timber merchants in all the States are fully co-operating and are showing their active appreciation of the value of research to the timber-using industries. The Council has not yet been able, owing to financial considerations, to erect a properly equipped laboratory, but excellent use is being made of the limited facilities for experimental work which have been provided in the outbuildings at the Council's Head Office premises.

An important development during the year 1931–32 was the establishment of an industry in Western Australia for the production of tannin extracts from waste karri and marri barks. This industry is based on the results of the research work of the Division, and is a gratifying conclusion to years of experiment. It is anticipated that the industry will develop an extensive export trade.

A second important feature of the year's work has been the success which has attended the investigations on the prevention of wood taint in butter. The method of spraying with a solution of casein and formalin has been developed and tested out in a practical way. With the co-operation of the Australian Dairy Council and of associations of primary producers, semi-large scale shipments have been made to London of butter packed in boxes made of *Pinus radiata* (South Australia) and hoop-pine (Queensland). The results have been satisfactory and as soon as the complete results of the experimental shipments are available steps will be taken for the application of the process on a commercial scale. The successful development of the process will be of very considerable advantage to the dairy and timber industries. It will mean the utilization of a large quantity of Australian-grown timber to replace the white pine now imported. This would lead firstly to a considerable saving—estimated at £75,000 per annum—in the cost of the boxes, secondly to the utilization of Australian timber to the annual value of £150,000, and thirdly to the utilization of about £4,200 worth of casein per annum.

A third development of great interest has been what appears to be a definite promise of the early establishment of the paper-making industry in Tasmania from local hardwoods. Certain developments including amalgamation of commercial and financial interests make it probable that the coming year will see the necessary plant installed and at work. For some time it was almost impossible to get acceptance of the idea that hardwoods could be used for the manufacture of paper. The second battle was to persuade those interested that the small scale results could be repeated commercially. The third stage was the establishment of the soundness of the economics of the scheme. Each of these difficulties has been overcome, and the way is now clear for the establishment of what may develop into one of the largest and most important industries in the Commonwealth.

Very satisfactory progress has been made in the Division's work on timber seasoning, and during the year 1931–32 a third experimental kiln was installed, two kilns being unable to cope with the volume of work. A number of kilns and re-conditioning chambers have been installed in various parts of the Commonwealth in accordance with plans prepared by the Division. Definite seasoning schedules are being worked out for a number of the more important commercial timbers, and special attention is being given to *Pinus radiata* because of the very large operations

in South Australia in the growth and utilization of that timber. Particularly valuable progress has been made in seasoning work on hardwoods for use for the manufacture of cases and boxes. As a result, two firms have installed kilns in Victoria and one in Tasmania, and hardwood case sides 5–16 inch thick are being dried green off the saw in 36 hours, and case ends ¾ inch thick in three days. This rapid drying is very helpful in the efforts to establish the use of the hardwood case in Australia in place of the imported softwood case. Very valuable work has also been done in the treatment of " collapsed " timber.

In view of the difficulty in indentifying certain Australian timbers merely by an examination of the sawn planks and of the importance to the timber industries of devising simple methods for indentification, special attention is being given to that problem, and the results already obtained have proved to be of great assistance. The study of the chemistry of Australian timbers is being continued. This work will become of increasing importance with the development of industries based on chemical methods of utilizing wood such, for example, as the manufacture of paper, artificial silk, lacquers, &c. The small experimental plant for work on timber preservation has been extended so as to enable full sleeper lengths to be treated. Tests are being carried out with various methods of creosoting and valuable results have already been obtained. As an indication of the industrial importance of this branch of work, it may be mentioned that the various public utilities of Australia are faced with an annual bill of over £1,000,000 for necessary replacements of railway sleepers, telegraph poles, bridge timbers, &c.

A pamphlet on the preservative treatment of fence posts has been issued, mainly for the use of farmers. It gives all the necessary details and costs for the cheap preservation of posts on the farm. Methods of overcoming rot in stacks of stored wood have been devised and put into operation, with the consequent saving of large sums of money.

During the year 1931–32 a beginning was made in work on timber mechanics. It was decided to concentrate chiefly on box and crate testing which is one of the branches of work in which research is most urgently needed by the industries concerned. As a result of a grant by the Directors of the Commonwealth Bank from the Rural Credits Development Fund a standard box testing drum and a 30,000 lb. Universal testing machine were installed. This machine also enables such tests as nail-holding power of various timbers, efficiency of various types of nails, strength of strapping, &c., to be conducted. Some idea of the importance of the work and the scope for improvements and savings may be gathered from the fact that 10,000,000 to 15,000,000 boxes of commodities are exported annually from Australia, in addition to over 50,000,000 containers used for internal trade. In the six months during which this work has been in progress, nine industrial concerns have requested that tests be conducted on boxes made or used by them, and the work has already led to several firms testing out cases made of Australian hardwood to replace those made of imported softwood. Very satisfactory progress has been made on boxes for dried fruit (particularly for the purpose of rendering them insect-proof) and on the design of apple cases (particularly for the purpose of avoiding bruising).

9. *Cold Storage Investigations.*—Until the year 1931–32 the Council's investigations into problems connected with the preservation of foodstuffs, particularly by cold storage, had been confined largely to isolated problems, which, though yielding valuable results, were difficult to co-ordinate and did not adequately cover the field of urgent investigations required. Though it had long been the intention of the Council to develop this field of investigation in view of its great importance, particularly to our export industries, lack of funds and trained scientific investigators prevented the formation of a suitable organization. However, with the return to Australia of several investigators trained abroad under the provisions of the Science and Industry Endowment Fund, the Council established in August, 1931, a small Section of Food Preservation and Transport and appointed Dr. J. R. Vickery in charge of it; Associate-Professor W. J. Young continuing to act in the capacity of Adviser. The present programme of work includes investigations on (*a*) meat problems, (*b*) non-tropical fruits, (*c*) the maturation and transport of bananas, and (*d*) engineering and transport investigations.

As a result of a previous offer by the Queensland Meat Industry Board adequate facilities for investigations on the storage and transport of meat will be available near Brisbane at an early date. The work will be concentrated mainly on problems connected with the export of chilled beef from Australia to England. Other investigations will include studies of the most suitable bacon pig carcasses for export to England and of problems connected with the export of edible offals, such as livers, kidneys, brains, &c.

As regards non-tropical fruits the Council has entered into a co-operative arrangement with the Victorian Department of Agriculture for the pooling of resources for investigations on apples, pears and passion-fruit.

The investigations on the maturation and transport of bananas have been eminently successful, and it is gratifying to note that the results obtained are being applied commercially on a large scale.

Experiments on the treatment, storage and transport of citrus fruits are being continued and have already shown the way in which Valencia oranges can be stored satisfactorily for long periods.

10. *Miscellaneous Investigations.*—In addition to the work of its six main Divisions, the Horticultural Stations and the Section of Food Preservation and Transport referred to in the preceding paragraphs, other investigations are either in progress or have already been completed. The extraordinarily valuable and spectular results achieved in the destruction of prickly pear by insect enemies are now well known. The scientific work is being carried out by the Commonwealth Prickly Pear Board, which was created by the former Advisory Council of Science and Industry, and has continued as an important activity of the Council in co-operation with the Queensland Prickly Pear Lands Commission and the New South Wales Department of Agriculture. The progress made in the destruction of pear, particularly by *Cactoblastis cactorum* is most satisfactory, and it is estimated that the original heavy growth of pear has already been destroyed over at least 10,000,000 acres. An Act for the settlement of the cleared lands has been passed by the Queensland Parliament, and large areas of land formerly heavily infested by the pest are being settled and brought into production. It is anticipated that in the next few years many millions of acres of further lands will be freed from the pest. It is impracticable to assess either the capital value of the work or the value of the increased production and benefits which are ensuing, but it is obvious that they must run into very large sums of money.

As regards investigations on the production of liquid fuels from coal, the Council has continued to maintain intimate contact with developments in other countries. Arrangements have been made for the return to Australia of an officer trained under the Science and Industry Endowment Fund, and subsequently employed by the British Fuel Research Board at its Research Station at Greenwich. This officer will be available to furnish authoritative advice on fuel research problems and on schemes for the treatment of fuels in Australia.

The investigations on the mineral content of gold bearing ores have been continued with satisfactory results, and surveys made in various districts have indicated the existence of promising lodes worthy of further prospecting by bores, shafts and crosscuts.

The Australian tobacco investigations are under the control of a Committee on which the Council is represented. The scientific investigations are being conducted by the Council's Division of Plant Industry.

Throughout the course of a year the Council receives many hundreds of requests for scientific information and advice on matters concerning the primary and secondary industries of the Commonwealth. There is no doubt that in this field the Council has met a definite want, and has indirectly been responsible for many improvements in industrial practices.

To sum up, the Council has already been responsible for large national savings many times greater than its annual cost, and its possibilities in the not far distant future are even greater. That various commercial and other interests concerned are fully aware of this position is indicated by the numerous grants in money and in kind and the assistance in the way of gratuitous services rendered to the Council. Sufficient has been said in this summary to indicate that scientific research is not only a most potent instrument in the efficient development of our industries and in the financial and economical rehabilitation of the Commonwealth, but also, as was asserted in last year's Report, that it is capable of paying higher dividends in the form of practical results than any other type of national activity.

11. *Financial Provision for Research.*—At the Imperial Conference, 1930, special attention was given to the question of the provision of funds for national research. The view was expressed that whilst the existing machinery for Imperial co-operation might be regarded as reasonably satisfactory, its efficacy will ultimately depend on the provision of adequate funds to enable the services in the different parts of the Empire to maintain and extend the scope of their operations. Attention was drawn to the danger of Governments, in times of financial stress, being tempted to economise in expenditure on scientific services on the grounds that the need for them is less urgent than for other forms of expenditure, and that research can well be put on one side until prosperous conditions return. The need for scientific investigations and for the application of the knowledge gained thereby is more urgent when industries are depressed

than when they are flourishing. Research cannot be expected to yield fruitful results if it is pursued in fits and starts. The Research Committee of the Conference strongly urged that the severe economic depression from which the British Empire, in common with the rest of the world, is suffering, should be regarded as a reason not for the curtailment but for an expansion of expenditure on research. The greater utilization of the help which science can give will be a potent factor in the rehabilitation of existing industries, including agriculture, no less than in the development of new ones.

The matter has been considered by the Council, which passed a resolution expressing appreciation of the financial support given by the Commonwealth Government to the work of the Council in a time of financial stress, of the generous gifts of money and material provided from outside sources (particularly from the Empire Marketing Board, the Pastoral Research Trust Fund and the Rural Credits Development Fund of the Commonwealth Bank) and of the valuable co-operative assistance given by the Government Departments, Universities and other institutions. The Council reiterated the belief that a country like Australia, which is dependent for its prosperity to such an extent on the welfare of its primary industries, must look to an increasing degree to scientific research to overcome many of the problems with which these industries, and particularly the pastoral and agricultural industries, are faced and thus to help to place them on a more secure basis.

II. ORGANIZATION AND CO-OPERATION.

1. *Major Divisions of Council's Work.*—In regard to the major sections of the work on which the Council is engaged, it has adopted the policy of establishing Divisions and of placing each Division under the control of a recognized authority in the sciences concerned. Up to the present six Divisions have been formed, viz. :—

(i) The Division of Plant Industry—Dr. B. T. Dickson, Ph.D., &c. (Chief).
(ii) The Division of Economic Entomology—Dr. R. J. Tillyard, F.R.S., D.Sc., &c. (Chief).
(iii) The Division of Animal Nutrition—Sir Charles Martin, F.R.S., D.Sc., &c. (Chief).
(iv) The Division of Animal Health—Dr. J. A. Gilruth, D.V.Sc. (Acting Chief).
(v) The Division of Soil Research—Professor J. A. Prescott, M.Sc. (Chief).
(vi) The Division of Forest Products—Mr. I. H. Boas, M.Sc. (Chief).

In addition to these six Divisions, the Council in August, 1931, established a Section of Food Preservation and Transport. A considerable number of other investigations are also either in progress or have already been completed.

2. *The Council.*—Since the last report was made two meetings of the full Council have been held, one in August, 1931, and the other in April, 1932. Unless special circumstances arise two meetings are held each year, of which one is sufficiently early to allow of consideration of draft Estimates of expenditure for the following financial year. The present constitution of the Council is given elsewhere in this Report (*see* Appendix).

3. *Executive Committee.*—Under the Act constituting the Council, in between full meetings of the latter, all its powers and functions are vested in the Executive Committee. During the period under review 25 meetings of the Executive Committee, allowing one meeting per day, were held. The 224th meeting of the Committee was held on 21st June, 1932.

4. *State Committees.*—The constitution of the State Committees of the Council, whose main functions are to advise regarding the general business of the Council, and regarding any particular matter of investigation and research, provides for representation of the scientific sections of State Departments and of different branches of science and industry. Provision for the co-option of additional members enables each Committee to be so constituted that all the major industrial and scientific activities in each individual State may be given a voice on the local body. The personnel of the State Committees is given in an Appendix to this Report.

In practice, it has proved that the State Committees have provided the Council with a facile and rapid means of obtaining complete information on different aspects of particular problems. They have also ensured that any important information obtained from State sources is a well-balanced statement of the position, viewed from all aspects. The State Committees, especially those far distant from headquarters of the Council, have also served on occasions to draw attention to problems previously little known or of which the importance and potentialities had not been fully realized.

5. *Co-operation with State Organizations.*—One of the duties of the Council is to co-operate with State organizations with a view to the utilization of facilities and staffs available in the States and the prevention of unnecessary overlapping. The Council is gratified at the co-operative assistance rendered to it both by Commonwealth and State Departments and by the Universities. Not only have these bodies willingly adopted suggestions for co-operation made to them by the Council, but they have also in many cases themselves freely offered assistance. In previous issues of the Council's Annual Reports, particulars were given of the various investigations that are being conducted in co-operation with one or more of these bodies. It is not necessary to repeat these particulars in this Report. It will suffice to state that very close co-operative arrangements have been established with all these scientific departments and other similar organizations throughout the Commonwealth, and that by far the greater part of the Council's investigations is, in fact, being conducted on a co-operative basis with one or more of them. In particular, as will appear from later parts of this Report, the Council has derived great advantage from its close association with the Waite Agricultural Research Institute of the University of Adelaide.

6. *Imperial Co-operation.*—An important function of the Council is that of acting as a means of liaison between the Commonwealth and other countries in matters of scientific research. Co-operative arrangements have been completed with several institutions in Great Britain, and satisfactory relations, particularly for the interchange of information and publications, have been established with a large number of scientific bodies throughout the world. The Council attaches great importance to the carrying out of investigations in certain fields of work on an Imperial basis. In this connexion, very close relations have been maintained with the Empire Marketing Board. The constitution and aims of this body were outlined in the first Report of the Council. It has been most generous in contributing towards the cost of Australian investigations. Details of the various co-operative arrangements entered into by the Board are mentioned in the appropriate sections that follow. In addition to organizations in Great Britain, close relations have been established with bodies corresponding to the Council in other parts of the Empire.

7. *Agricultural and Pastoral Research.*—As a great deal of the work of the Council relates to problems affecting the agricultural and pastoral industries, special mention may be made of one or two matters concerning the organization and co-operation with respect thereto :—

(i) *Standing Committee on Agriculture.*—The Council's Standing Committee on Agriculture was appointed in 1927, and consists of the permanent heads of the six State Departments of Agriculture and of representatives of the Council. The principal objects in creating the Committee were, firstly, to ensure that there shall be intimate collaboration between the Council and the State Departments of Agriculture, and, secondly, to obviate undesirable duplication of effort in research work. Ordinarily the Committee meets twice a year, one meeting being held concurrently with the meeting of the State Ministers of Agriculture and the other some six months later. Owing mainly to the need for economy in expenditure on travelling, only one meeting of the Standing Committee was held during the year 1931–32, viz., in January, 1932. Some of the more important matters considered at that meeting were :—Tobacco investigations, dairy investigations, pasture improvement, animal health investigations, pig problems, root-rot diseases in wheat, entomological problems, chemical control of weed pests and register of wheat varieties. It will be realized that the Standing Committee on Agriculture performs a most useful function in respect of co-ordination and development of research on agricultural and pastoral problems in Australia.

(ii) *Register of Agricultural Research.*—In order that research workers in Australia may be cognizant of the investigations which are being undertaken by the Council and by the State Departments of Agriculture and other institutions, arrangements were made for the compilation by the Council of a Register of Agricultural Research from information furnished by the various Departments and Institutions concerned. Copies of the first Register were made available in 1928, and a Supplement bringing it up to date furnished in the following year. A new edition is in process of compilation.

The Register has been of very considerable use in promoting direct contact between workers on various problems and in furnishing information not previously available as to the research activities on agricultural and pastoral problems in the Commonwealth. The Register has thus helped materially to bring about co-ordination of effort and to obviate duplication.

(iii) *Imperial Agricultural Bureaux.*—As a result of recommendations made by the first Imperial Agricultural Research Conference, which met in London in 1927, arrangements were made for the organization of eight Imperial Agricultural Bureaux whose principal function will

be to act as effective clearing houses for the interchange of information of value to research workers in agricultural science throughout the various parts of the Empire. An account of the scheme of organization and work of the Bureaux was published in the Council's quarterly Journal, Vol. 2, No. 2. The eight Bureaux which have been established are as follow :—

IMPERIAL AGRICULTURAL BUREAUX.

Bureau.	Location.	Direction.	Australian Correspondent.
Animal Nutrition ..	Rowett Research Institute, Aberdeen	Dr. J. B. Orr .. Deputy : Mr. H. Crow	Sir Charles Martin, Chief of Division of Animal Nutrition (C.S.I.R.), Adelaide
Animal Genetics ..	Animal Breeding Research Department, Edinburgh University	Professor F. E. Crew Deputy : Dr. F. Fraser-Darling	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne
Fruit Production ..	East Malling Research Station	Mr. R. G. Hatton .. Deputy : Mr. D. Akenhead	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra*
Soil Science	Rothamsted Experimental Station, Herts	Sir John Russell .. Deputy : Mr. G. V. Jacks	Professor J. A. Prescott, Chief of Division of Soil Research (C.S.I.R.), Adelaide
Plant Genetics (Herbage Plants)	Welsh Plant Breeding Station, Aberystwyth	Professor R. G. Stapledon Deputy : Dr. R. O. Whyte	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra
Plant Genetics (Plants other than Herbage)	Plant Breeding Institute, Cambridge	Sir Rowland Biffen Deputy : Dr. P. S. Hudson	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra
Agricultural Parasitology	Institute of Agricultural Parasitology, St. Albans	Professor R. T. Leiper Deputy : Dr. B. G. Peters	Dr. I. Clunies Ross, Parasitologist, Division of Animal Health (C.S.I.R.), Sydney
Animal Health ..	Veterinary Research Laboratory, Weybridge	Dr. W. H. Andrews Deputy : Mr. W. A. Pool	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne

* Deputy Correspondent, Mr. W. M. Carne, Senior Plant Pathologist, Division of Plant Industry (C.S.I.R.), Hobart.

III. PLANT INVESTIGATIONS.

1. *General.*—During the year, the glasshouses which are essential for continuous investigations into plant problems were completed, and the equipment for control of soil and air temperature and moisture installed. The funds for the erection of the glasshouse were made available partly by the Directors of the Commonwealth Bank from the Rural Credits Development Fund, partly from the funds of the Australian Tobacco Investigation Committee, and partly from other sources. In addition, the Council is indebted to the Lightfoot Refrigeration Company Limited for a gift of refrigeration plant and equipment which enable control work to be undertaken.

A room was added to the south-east corner of the glasshouse block for the treatment and storage for ageing of tobacco from various parts of the Commonwealth. The area at Duntroon has been laid out in experiment plots for plant pathology, genetics, plant introduction and agrostology, and the barn rendered vermin-proof for the storage of grain and pasture plant seeds.

2. *Plant Diseases.*—In the preceding Annual Reports of the Council, attention has been directed to the very large losses incurred in Australia as a result of plant diseases and to the fact that it is estimated that the annual losses average about 10 per cent. of the value of all crops. Such a percentage corresponds to an annual loss of £12,000,000 per annum.

(i) *Plant Disease Survey.*—Since Mr. C. C. Brittlebank completed the recording referred to in the Annual Report for 1930–31 the staff of the Plant Pathology Section has incidentally continued the collection of records. Dr. Dickson, as time allows, is giving attention to the arrangement of the records in a form most suitable for general use by pathologists throughout the Commonwealth.

(ii) *Apple Diseases.*—As recorded in the Annual Report for 1930–31, Mr. W. M. Carne, was enabled, by a grant from the Empire Marketing Board to travel with a consignment of apples from Western Australia to England. While there he conferred with workers at the Low Temperature Research Station, Cambridge, the East Malling Research Station, and the Ditton Laboratory. Inspection of consignments of apples at the dock showed that bruising is a fertile source of loss, both directly as bruising and indirectly as the forerunner of fungal rots and breakdown. An account of the ways in which Mr. Carne considers the export of apples could

be improved was published in the Council's Journal for February, 1932. After his return, an investigation was commenced into the problem of the prevention of bruising as far as the type of case and method of packing are concerned. This is being carried out in co-operation with the Division of Forest Products. Second in importance to bruising as a factor in export apple marketing is water-core and the related breakdown. During the coming year, Mr. Carne is to be located in Tasmania in order to continue work on water-core and " cork " incidence and control.

(iii) *Tobacco Diseases.*—The year 1931–32 was not an epidemic year for downy mildew (blue mould) of tobacco although it occurred in every State except Tasmania, and was widespread in Queensland. The view that the disease is transmitted through the seed, first suggested by seed germination tests, was corroborated by Dr. H. R. Angell and Mr. A. V. Hill as they have found the mycelium of the fungus in the capsule tissues and in seeds in the capsule. The importance of obtaining guaranteed healthy seed is thus rendered beyond question. The Council's Bulletin (No. 65) dealing with the results of these studies is now in the press, as is also a pamphlet couched in easily readable form, and which the Australian Tobacco Investigation intends for issue to growers.

During Dr. Dickson's visit to Mareeba, North Queensland, in April, 1932, he found that another disease, leafspot, probably caused by *Cercospora* sp. was prevalent throughout the area. The spotting, already present in the field but not always easily noticed, became prominently evident during curing, and it undoubtedly reduces the quality of the leaf. This disease will be investigated during the coming season.

(iv) *Wheat Diseases*—(*a*) *Flag Smut.*—Miss Jarrett has continued her work on this disease which is progressively increasing as a serious factor in wheat production in Australia. The main object of these investigations is to obtain information on which to base the breeding of strains of wheat even more resistent to flag smut than those at present known. By developing a special method of inoculation it has been found that no variety or cross so far tested is consistently immune. Certain varieties such as Bomen, Bunyip, Cedar, Galgalos and Geeralying show promise of resistance, as they do not manifest the disease to such a degree as others, for example, Canberra, Federation, Gluyas and Waratah. Tests were continued on the F3 generation of crosses made by Mr. McMillan in 1929. Approximately 250,000 seeds were individually tested for reaction to flag smut during the year.

(*b*) *Root-rots.*—State Departments of Agriculture again collaborated by supplying specimens of diseased plants from various sources. Mr. W. L. Geach found that *Fusarium culmorum*, which had not hitherto been regarded as a cause of root-rot of wheat in Australia, was, in fact, serious and quite widespread during the season. An article dealing with this root-rot disease was published in the Council's Journal for May, 1932. Dr. Angell continued the investigation into the remaining group of organisms causing root-rot, viz. :—*Ophiobolus*, *Helminthosporium* and *Wojnowicia*. Experimental data are being collected on the influence of soil type on the development of *Ophiobolus graminis* and the incidence of the root-rot. These influences appear to be so well marked that a systematic study is in progress to determine the factors responsible for the differences observed. By a co-operative arrangement with the Biological Branch of the New South Wales Department of Agriculture, Mr. Hynes of that Department is undertaking studies of the organism *Helminthosporium sativum* and Dr. Angell is carrying out the tests to determine the relative susceptibility of various wheats to it. Several hundred varieties of wheat are under test in this way both with respect to *O. graminis* and *H. sativum*.

(v) *Spotted Wilt of Tomatoes.*—The co-operative work on spotted wilt of tomatoes between the Waite Institute and the Division of Plant Industry, C.S.I.R., was continued with further studies of symptoms and inoculation technique in order to facilitate the tests for disease resistance and in the actual disease resistance studies.

(vi) *Pineapple Diseases.*—The results of the investigations by Dr. B. T. Dickson and Dr. H. R. Angell of the Division of Plant Industry, in co-operation with Mr. J. H. Simmonds of the Queensland Department of Agriculture and Stock, were published in the Council's Journal for August, 1931, and issued to growers. The methods of control have since been widely adopted by growers from whom very favourable comments are received from time to time.

(vii) *Powdery Scab of Potatoes.*—The departure of Mr. Dowson (Tasmanian Department of Agriculture) from Tasmania severed his connexion with the Committee which, as a result, did not meet during the year. Powdery scab of potatoes was discovered on potatoes in Victoria, and it is reasonable to assume that it has been present in Victoria for years. At the request of the Department of Commerce, Dr. Dickson has presented a report dealing with the general position. In this report the world geographical distribution of the disease, the conditions necessary for its occurrence and the position in Australia are discussed. The disease is serious

only in areas characterised by cold, wet growing seasons, and elsewhere it is of minor significance. The view advanced is that on the mainland of Australia, powdery scab will not become a serious problem, and that the inspection services at ports can prevent the movement of diseased tubers.

(viii) *Coco-nut Diseases.*—Following the health survey of coco-nut plantations in Papua, a 40-acre block was made available and, by the aid of a grant of £200 from the Administration, a series of manurial and cultural tests was laid down. Certain of these are showing promise, but results cannot be available for a year or two.

(ix) *Pea Diseases—Root-rot of Peas.*—This disease has been a matter of concern for some years in the Longford district of Tasmania. Dr. Dickson visited the area in October, 1931, and found the first field evidence of the diseases for that season. Specimens collected there and examined in Canberra showed the presence of a *Fusarium* and an *Aphanomyces*. It has been arranged that Mr. W. L. Geach will undertake a study of the problem, and accordingly he has laid out test plots at Evandale and Cressy with the co-operation of growers. Soil, old plants and peas were collected and the disease has been reproduced in the glasshouse.

3. *Genetics.*—The work of this Section, as outlined below, has been conducted by the following officers :—Messrs. J. R. A. McMillan, H. F. Smith, J. A. Harris and K. Loftus Hills.

(i) *Flag Smut.*—Investigations into the inheritance of reaction to the organism causing flag smut of wheat have been continued. Second generation results from 28 different crosses were obtained in the greenhouse and field last season. This year a third generation is being raised. It is obvious that the mode of inheritance is not simple, there being indications of monohybrid and dihybrid ratios in which inhibitory factors are operating.

(ii) *Drought Resistance.*—Tests to determine the relative drought resistance of some 28 varieties of wheat were conducted in pots last year. At a critical stage, they were subjected to an artificial drought and certain differences were shown. Other varieties are being treated now. (*See* also 4 Plant Physiology.)

(iii) *Yield.*—Investigations on the factors affecting yield in wheat are being continued. In an endeavour to understand this more thoroughly, the growth, yield, tillering, &c., of two different types of varieties have been compared. An " area-census " of a wheat field has indicated that the harmful effect of variation in density of seeding within a field has probably been exaggerated, and that Engeldow's census method for studying yield in the field may not be used to test the ability of different varieties to compensate for variation of spacing. Study of physiological relations between tillers of a wheat plant, while supporting the conception that the tiller should be considered as the principal unit for analysis of yield, nevertheless indicates that the plant as an individual should not be disregarded. Observations on the relation between rate of growth, tillering and maturity were made on two varieties in 1931 and are being extended this year to ten varieties. The variety trial is being continued at Duntroon Experiment Farm in order to determine the relationship between yield and environment.

(iv) *Grass Clumps.*—The solution of the problem of mode of inheritance of grass clumps in wheat appears to be at hand. It has been proved that at least nine (9) pairs of genes are operating; six of these are complementary, and in the dominant form condition the development of grass clumps; the remaining three are also complementary, and in the dominant form inhibit the development of the characteristic. The State Departments of Agriculture, Dr. W. L. Waterhouse of Sydney University, and Dr. Phipps of the Waite Institute, have afforded valued assistance in this work.

(v) *Garnet x Waratah.*—A detailed study of the inheritance of morphological characteristics, together with yield and grain type is being made in the cross Garnet x Waratah. Practically all the data on the second generation have been obtained, although it has not yet been analysed. Third generation is being grown at present in a carefully conducted yield trial at Duntroon.

(vi) *Maize.*—The maize improvement work at Gatton College has been continued. The stage has been reached now when some first-generation crosses are being tested. Some of these are most promising.

4. *Plant Physiology.*—The main problem in this Section is with drought resistance of wheat or the ability of a plant to withstand a period of drought without any material ill-effect or decrease in ultimate yield. It is necessary to know why differential drought resistance occurs and how to measure it reliably and with facility so that the results may be applied to breeding. The conditions are complex, but attention is being particularly directed by Mr. Calvert to catalase activity, to " bound water ", and to root systems. (*See* also Section 3, Genetics (ii).)

5. *Agrostology*—(i) *Introduced grasses and legumes.*—Some dozen promising pasture plants selected by Dr. McTaggart are being examined thoroughly by Mr. T. B. Paltridge and Mr. H. K. C. Mair with a view to their ultimate use in suitable zones.

(ii) *Grassland Map.*—Material is being collected for the preparation and publication of a grassland map of Australia. Such a map will be of considerable use in pasture improvement work throughout Australia.

(iii) *Glen Elgin Investigations.*—At Glen Elgin, New South Wales, an ecological investigation of a section of poor type grassland has been undertaken on property kindly made available by Mr. E. D. Ogilvie, Ilparran, with a view to determining the reason for the reported temporary thriving, then distinct falling off, and ultimate death of sheep after about nine months of grazing, following long continued pasturing by cattle on pastoral properties on the eastern slopes of the dividing range. This investigation was carried on during the past year by Mr. T. B. Paltridge, Assistant Botanist, following the initial ecological work of Dr. J. White-Haney. The results obtained show that there exists in the herbage no special plant species which might be of high cystine content, and which, because of this, might account for the temporary thriving of sheep when first depastured on this type of country. They point rather to the probability of incipient mineral (phosphate) deficiency being largely responsible for the phenomena observed.

6. *Seed-Testing.*—It was stated in the last Annual Report of the Council that certain steps had been taken with a view to reaching uniformity throughout Australia in the methods of seed-testing. Dr. B. T. Dickson, at the request of the Council's Standing Committee on Agriculture, prepared a report on the technique of seed-testing as practised in the various States and in countries abroad. In July, 1931, Mr. W. M. Carne attended the International Seed Testing Congress at Wageningen, Holland. It was found that the points of difference between Dr. Dickson's report and the International scheme were of a minor nature, and arrangements were accordingly made by the Standing Committee on Agriculture for Dr. Dickson to consult the appropriate State officers with a view to bringing Australian technique into line with the International scheme.

7. *Plant Introduction*—(i) *General.*—Strictly limited financial resources prevent field exploration of other countries with a view to finding promising plants and necessitate reliance on correspondence. Nevertheless to date some 2,683 introductions have been made from 44 different countries. These are all tested under quarantine conditions, at first as a safeguard, and later, if in any way promising, they are multiplied to obtain enough seed with which to work further on them. Thus Dr. McTaggart and Mr. Hartley have brought in, recorded and sown 649 grasses, 628 leguminous plants, 994 wheats, and 412 miscellaneous plants including seven rubber-producing, four insecticidal, and eight fibre plants. Not all the plants brought in are necessarily worth while, and, in fact, only a small proportion can be expected to be so. However, a fair number are definitely promising and 216 lots of seed have been sent to State Departments for field tests.

(ii) *Exchanges.*—To date 558 samples of seed have been sent abroad in exchange for some of the 2,683 received.

(iii) *Record of Introductions.*—The compilation of a record covering all parts of Australia as far as the introduction of cereals and forage plants is concerned is in hand.

8. *Biometrical Work.*—Miss F. E. Allan continued the biometrical studies in connexion with the various experimental plant studies in the Division, and carried out similar work for the Waite Agricultural Research Institute and Gatton College in Queensland.

9. *Fruit Problems*—(i) *Light and Heavy Cropping of Apples.*—Mr. Carne is engaged in planning work in Tasmania, in close collaboration with the Department of Agriculture, dealing with root studies, dormancy and bud burst and their effects on the cropping of apples.

(ii) *Bud Studies.*—Mr. Barnard is continuing the investigations into the time of and conditions influencing the differentiation of fruit buds. In co-operation with Mr. F. M. Read, of the Victorian Department of Agriculture, a useful publication has been prepared, and will shortly appear in the *Journal of Agriculture* for Victoria covering the work to date in that State with apples and pears. Similarly with Valencia oranges, Mr. West, of the Commonwealth Research Station at Griffith, and Mr. Barnard are co-operating in an investigation into the irregular bearing of that crop.

10. *Noxious Weeds.*—Information has been supplied, in response to requests, concerning a number of weeds, but this work is incidental to the other activities of the Division.

11. *Herbarium.*—The herbarium is being added to gradually, but this work again is incidental to the general programme of the Division.

12. *Tobacco Investigations.*—The scientific work of the Australian Tobacco Investigation is under the directorship of the Chief of the Council's Division of Plant Industry (Dr. B. T. Dickson) who is responsible to a Committee with Mr. J. G. McLaren, C.M.G., Chairman, Dr. A. C. D. Rivett and the Hon. J. Gunn as members working in close co-operation with the Council. A report is presented to this Committee, but it may be mentioned here that the programme includes studies of diseases (*see* 2 (iii)), the determination of suitable areas for the proper growth of tobacco, studies of the smoking qualities of tobacco from different areas and experiments to determine methods of improving smoking quality.

IV. ENTOMOLOGICAL INVESTIGATIONS.

1. *General.*—In previous issues of the Council's Annual Reports reference has been made to the enormous losses suffered by Australia's agricultural and pastoral industries through the depredations of insect enemies. No estimates of the total loss to Australia are available, but Dr. L. O. Howard, formerly Chief of the United States Bureau of Entomology, has stated that in his country the economic losses due to insects amount to £400,000,000 annually, or in other words, the work of more than 1,000,000 men is nullified every year. He believes that the insect enemies will ultimately be conquered, but that that condition will not be reached until the danger is more generally appreciated. The late Mr. A. M. Lea, formerly entomologist at the South Australian Museum, Adelaide, has estimated that in South Australia more than one-tenth of the crops are destroyed by insects. The Council is continually receiving requests for help in connexion with insect pests, and in order to enable it to cope with some at least of the more important problems of national or interstate significance it decided some years ago to establish a Division of Economic Entomology with its main laboratories and insectaries at Canberra. This has been rendered possible largely as a result of generous contributions by the Empire Marketing Board towards the capital cost and maintenance of the laboratories, and by the Directors of the Commonwealth Bank from the Rural Credits Development Fund towards the cost of the insectaries.

The results of the Division's investigations during the past year include the introduction of new parasites of the buffalo-fly into Northern Australia, definite progress in research on the blowfly problem, the discovery of a pollen-substitute on which bees can be reared from the egg stage to maturity under laboratory conditions, the liberation of a promising species of seed-fly in Queensland for control of Noogoora burr, the introduction of a predatory enemy of the pine *Chermes* pest and the working out of practical methods for control of that pest, the demonstration of practical control of the *Aphodius* grass-grub on lawns, the discovery in New Zealand of a promising parasitic enemy for control of the Tasmanian grass-grub (*Oncopera*), and the discovery in Western Australia of a predatory mite which attacks clover springtail (lucerne flea).

2. *Entomological Control of Noxious Weeds.*—The work of this Section has been continued with Mr. G. A. Currie as senior entomologist, Mr. S. Garthside at Farnham Royal, England, and Mr. S. G. Kelly at Manhattan, Kansas.

(i) *St. John's Wort* (*Hypericum perforatum*).—During the year further consignments of the three *Hypericum* feeding species of *Chrysomela* were received from the Farnham Royal Laboratory (Great Britain). Reports from the localities where consignments of these beetles were put out last year indicated that they have not yet become established, and it appears that they suffer very severely from the attacks of meat ants, ground spiders and other enemies, as well as from the extremely dry summers. Attempts are now being made to establish colonies at a higher elevation (2,000 to 3,000 feet) between Bright and Harrietville, Victoria. Shipments of the moth *Lathronympha hypericana* have begun from Farnham Royal, and the Council's investigator located there has worked out the life-histories of the two much larger moths *Anaitis plagiata* and *A. efformata*, of which the larvae have been shown by careful tests to be confined to St. John's wort. He is also working on another very promising insect, *Aphis chloris*, which, if proved harmless to other plants, should do well in Victoria, as it will find the numerous ants friendly towards it instead of inimical.

(ii) *Noogoora Burr* (*Xanthium pungens*).—The seed-fly, *Euaresta aequalis*, successfully passed all its tests against economic plants in Australia, including those on various tropical and sub-tropical fruit and on cotton bolls, and has been liberated during the seeding period of the burr at Biloela, Queensland, with the co-operation of an officer of the Queensland Department of Agriculture and Stock. In the United States, Mr. S. G. Kelly is continuing the work of preparing consignments of this insect for Australia, and has also made considerable progress with his studies of a number of promising beetles whose larvae bore into the plant and destroy it, viz., *Cylindrocopterus adspersus*, *Baris callida*, *B. xanthii*, *Hippopsis lemniscata*, *Ataxia hubbardi* and *Dectes spinosus*. The first-named of these appears to be extremely deadly, one larva usually killing a whole plant.

(iii) *Ragwort* (*Senecio jacobaea*).—A further batch of caterpillars of the cinnabar moth, *Tyria jacobaeae*, was liberated in November last year near Morwell, Victoria.

(iv) *Bracken Fern.*—Mr. Kelly has located an area of bracken fern in Northern Kansas in which the moth *Papaipema* occurs and is studying its attacks on the fern.

3. *The Buffalo-fly pest* (*Lyperosia exigua*).—(i) *General.*—A general and historical account of this problem and of the attempts that have been made to alleviate it was given in the Council's Journal for November, 1931. Professor Handschin and Mr. G. L. Windred have completed their work on the pest in the Netherlands Indies, and the former, on the termination of his two years' engagement, has submitted a preliminary report on the results of his work, which will shortly be published as one of the Council's Pamphlets (No. 31).

His main conclusions are (i) that temperature controls the presence or absence of the fly in any given locality, while the moisture content of the dung regulates its abundance when present; (ii) that the minimum temperature at which the fly can exist is about 72 degrees Fahr. and that it thus appears that the south-west of Western Australia, including Perth and Fremantle, is safe from the fly, while in Eastern Australia it may be expected to spread to a point somewhat south of Rockhampton, but not as far as Southern Queensland or Northern New South Wales; and (iii) that the fly is always worst on cattle in poor condition, so that in North Australia it is just as likely that the fly is bad on cattle because they are in poor condition as it is that the cattle are in poor condition because of the attacks of the fly, and that all damage done to cattle by flies of different kinds, such as March flies, Bush flies, &c., is put down indiscriminately to the buffalo-fly; but nevertheless the fly is a serious danger and strict quarantine should be applied to prevent its spread southwards.

(ii) *Biological Control.*—Of all the parasites studied, species of *Spalangia* (a small parastic wasp) were found to be the most effective. Native species of this genus occur both in Java and in North Australia, but the former is the more effective. Professor Handschin first of all evolved a race of the Javanese parasite living entirely on buffalo-fly puparia (normally the parasite attacks a number of Muscid flies), and then crossed this with the North Australian species. It was found that, when an Australian female was mated with a Javanese male, the progeny lived much longer and laid more than twice as many eggs, whereas the opposite cross was less effective than the pure strain. Consignments of both species are now being reared at Burnside, North Australia, and an experimental liberation is being made of Javanese males and of Australian females which have been paired with such males.

If this experiment results in increased parastic control of the fly, it is proposed to extend it later to the Gulf Country of Queensland.

4. *The Sheep Blowfly Pest.*—During the year a joint Blowfly Committee representative of the Council and the New South Wales Department of Agriculture was set up largely with a view to co-ordinating the activities of those officers of the two organizations who are engaged on the investigation of aspects of the blowfly problem. This Committee, which consists of Dr. J. A. Gilruth (Chairman) and Dr. R. J. Tillyard for the Council and Dr. H. R. Seddon and Mr. W. B. Gurney for the Department with Dr. I. M. Mackerras as Secretary, has paid considerable attention to the preparation of a comprehensive report giving a general survey of the existing knowledge of the blowfly problem from the entomological and veterinary sides. This report is now complete and will shortly be jointly published by the Council and the Department.

Reverting to the work of the Council's Division of Economic Entomology, six further species of flies were recorded during the year as playing a part in striking sheep; of these, three are primary flies (all species of *Calliphora*), one a secondary fly (*Microcalliphora varipes*) and two tertiary flies (*Musca domestica* and *Fannia australis*). Further confirmation was obtained that the secondary fly *Achaetandrus rufifacies* (large hairy maggot fly) is the most effective enemy of the primary flies, and also that, of the primary flies, *Lucilia cuprina* was the most dangerous and responsible for the great majority of strikes.

The following special lines of research have also been carried out:—

(i) *Studies of the Flies.*—Miss M. Fuller has published a paper giving the diagnostic characters of the maggots of twelve species of flies concerned in striking sheep. She has also continued her record of the seasonal prevalence of flies at Canberra, the results agreeing fairly closely with those of the previous year. She also showed that increased sunshine in spring and autumn produced increased activity of *C. stygia*, whereas in the summer, when sunlight is intense, an opposite effect was observed. A continuation of her studies on competition between blowfly larvae has brought out the two interesting facts (*a*) that competition between primary species results in the emergence of a relatively large number of small-sized flies, whereas (*b*) competition between primary and secondary flies results in the production of a relatively small number of larger flies. The large hairy maggot has been shown to devour all primary maggots with equal avidity, but, in addition, it has a definite repellent action on *Lucilia* maggots.

Pure cultures of the following flies have been reared in the insectary :—*Lucilia cuprina*, *L. sericata*, *Calliphora stygia*, *C. augur* and *Achaetandrus rufifacies*. Dr. M. J. Mackerras has succeeded in crossing the two species of *Lucilia* and has also studied the effects of various conditions on adult fertility and maturation of the eggs.

(ii) *The Problem of Susceptibility.*—Experimental crutch strike, body strike and pizzle strike have been produced in the insectary, using pure cultures of the primary flies mentioned above. All types of strike are found to be fundamentally similar and are due (*a*) to predisposing causes inherent in the individual sheep, and (*b*) to certain immediate factors, such as free moisture on the skin and wool, condition of the fleece, presence of exudation, bacterial activity and climatic conditions, of which high temperature combined with humidity are the most important, though *C. stygia* is shown to be able to strike sheep at a much lower temperature than other species.

(iii) *Relation of Fly Abundance to Strike Incidence.*—An experiment has been devised in which large similar areas carrying similar flocks of sheep are to be compared over a considerable period of time. One area is to be trapped and the other left untrapped, records being kept of as many factors as possible.

(iv) *Carcase Treatment.*—Miss M. Fuller has shown that burial of carcasses in the early stages of decomposition favours the primary flies and that poisoning with arsenic before burial gives definite protection.

(v) *Trapping.*—Dr. Nicholson has studied the question of details of construction of traps with a view to evolving a perfect type of trap. He and Mr. M. R. Freney have tested a large variety of baits, and the latter worker has demonstrated that treatment of ordinary baits, such as liver or blowfly soup, with a solution of sodium sulphide greatly increases their attractiveness and also their period of activity.

(vi) *Jetting and Dressings.*—Mr. M. R. Freney has made further studies of jetting fluids and Mr. C. R. Mulhearn has tested a number of proprietary fluids and dressings. Some of these were found to be highly irritating to the skin of the sheep and a really satisfactory jetting or dressing material has not yet been found. It has been arranged that in future requests for tests of proprietary specifics will be referred to the External Parasites in Sheep Sub-committee of the New South Wales Department of Agriculture.

5. *Orchard and Fruit Pests—Thrips.*—During the year, Mr. J. W. Evans completed his study of the life-history of the species of the thrips (*Thrips imaginis*) which from time to time causes severe losses to apple-growers and others. In addition he tested out a number of attractants and repellents likely to be of use in the control of the insect, and gave a certain amount of attention to the effect of meteorological conditions. The results of his work have recently been published in one of the Council's pamphlets (No. 30). Further work on the problem is now being carried out in co-operation with the Waite Agricultural Research Institute to which place Mr. Evans has been transferred, and where his investigations are under the direction of Dr. J. E. Davidson. The industry concerned has also recently created a Thrips Investigation League for the purpose of collecting funds for intensifying the co-operative work in which the State Departments of Agriculture in the southern States are also assisting.

6. *Deficiency Disease in Bees.*—Mr. G. A. Currie has been in charge of the laboratory work on this problem which is being investigated in co-operation with the Victorian Apiarists' Association assisted by a grant from the Rural Credits Development Fund. By using a hive with young bees in the insectary, feeding them with various pollen substitutes and noting the resulting effects on the pharyngeal glands, it has now been proved that a combination of casein with yeast offers an efficient substitute for pollen, stimulating satisfactory development of the glands and also enabling the larvae to grow to maturity. Field experiments along the same lines will be undertaken next season.

7. *Field Crop and Pasture Pests.*—Mr. H. Womersley has continued his work on the lucerne flea or clover springtail (*Sminthurus viridis*) and on the red-legged earth mite (*Halotydaeus destructor*) in Western Australia. He has discovered a promising enemy of the springtail in the form of a predatory mite, *Biscirus lapidarius*, accidentally introduced from Europe, and has succeeded in establishing this mite in the University grounds at Perth. Attempts are now being made to establish colonies of it in heavily infested localities in various parts of Western Australia. In co-operation with Mr. L. J. Newman, State Government Entomologist, spraying experiments have been continued for the control of both pests, and the possibilities of agrostological control are being studied also, with the assistance of officers of the State Department of Agriculture. Mr. Womersley has also completed a paper on the *Sminthuridae* of Australia, which is being published by the Council as one of its pamphlets. It shows that a number of introduced and native springtails are pests of clovers and other pastures, and gives methods of distinguishing the various species.

8. *Termite (White Ant) Problem.*—Mr. G. F. Hill, senior entomologist of this Section, and Mr. T. Greaves, assistant, have continued their work on the white ant problem. During the year tests of various materials and impregnated woods were carried out in co-operation with the Division of Forest Products. These included tests on untreated commercial timbers in termitaria in the field for the purpose of evaluating the termite-resistant properties of these timbers. One of the most interesting discoveries made is that the resistance of a particular species of timber to termite attack varies according to whether it is used in conjunction with a more resistant or a less resistant timber. Poisoned baits are being tested both at Canberra against *Eutermes* and at Darwin, Northern Territory against *Mastotermes*. In addition, some attention has been given to the causes of destruction of commercial forest trees ; systematic work is being continued with a view to the preparation of a complete Termite Map for Australia ; and methods of maintaining laboratory colonies for the purpose of tests over long periods are being studied.

9. *Section of Systematic Entomology.*—During the year Mr. A. L. Tonnoir, senior entomologist of this Section, and his two assistant entomologists, Miss W. Kent Hughes and Miss L. Graham, carried out a considerable number of economic researches in addition to their systematic work. The total additions to the collections amounted to 6,200 specimens. A large number of specimens was indentified for various institutions in Australia, New Zealand, India and Europe, and identifications of Australian specimens were received in return from outside sources. Systematic work was carried out on *Phlebotomus*, *Chermes*, grasshoppers, Australian Coleoptera, Australian Hymenoptera, and on the hymenopterous parasites of the buffalo-fly. The fol owing economic researches were carried out :—

(i) *Pine Chermes.*—Work on this insect, which is proving a pest of Australian plantations of pines (*Pinus radiata* and others), was begun last October. Two promising predatory enemies of the pest have been shipped out from England and one of these (*Leucopis*) is now being tried out at Canberra. The other (*Hemerobius*) was tested against *Leucopis* and found to attack it, so it will not be liberated unless *Leucopis* fails. A study of the life-history of the *Chermes* pest in Australia has been made together with a survey of its natural modes of spread, amount of damage and possible methods of checking. Experiments in control by absorption of certain salts by the pines and by dipping nursery seedlings before planting (a method which is apparently successful in New Zealand) are also being carried out.

(ii) *Tasmanian Grass Grub (Oncopera).*—During the year, attempts were made to introduce the parasite *Hystricia* from New Zealand, but unfavourable weather prevented the success of the experiment. It has been decided to send an officer to New Zealand in the coming spring to carry out a further study of the life-history of the parasite and to organize a method of introduction into Australia. The *Oncopera* grub is the cause of heavy losses to agriculture both in Tasmania and in Victoria, and biological control appears to be the only method of attacking it.

(iii) *Scarab Grass-grub (Aphodius tasmaniae).*—This serious pest of lawns, greens and pastures has been studied by Miss Kent Hughes, who has worked out its life-history and shown that it hides in a vertical burrow in daytime and appears on the surface at night, devouring the leaves and stems of grasses and clovers. Complete success was obtained against this pest by using either a spray consisting of 4 lbs. lead arsenate to 100 gallons of water per acre, applied twice in one week early in March, and once again late in April, or by top dressing with powdered lead arsenate mixed with sand. The latter method is, however, too expensive to use on ordinary pastures and should be confined to lawns or greens.

(iv) *New Zealand Problems.*—In return for assistance received from New Zealand in work on *Oncopera*, oak-scale, and noxious weeds control, investigations on the New Zealand sandfly problem (*Simulium*) and on the parasites of various enemies of eucalyptus trees have been continued by the Section. During the year, 270 live dragonfly larvae and 1,200 live larvae of *Cardiocladius*, both predatory on *Simulium*, were successfully transported to New Zealand ; consignments of three enemies of the *Eriococcus* or gum scale were also sent over, and a preliminary study of the natural enemies of *Paropsis* or the eucalyptus leaf-beetle was begun.

(v) *Grasshopper Problem.*—Of late years plagues of grasshoppers have caused severe losses in various localities in Australia. The life-histories of a number of common grasshoppers have been worked out with a view to distinguishing the early stages of the plague and non-plague species. A survey of the hopper populations and egg-laying around Canberra was also carried out with a view to discovering some method of predicting forthcoming outbreaks in different localities.

V. ANIMAL HEALTH INVESTIGATIONS.

1. *McMaster Laboratory.*—In November, 1931, the McMaster Animal Health Laboratory in the grounds of the University of Sydney was handed over to the Council, and Dr. I. Clunies Ross as Officer-in-Charge was installed with his staff. Close co-operation has been established with the Department of Veterinary Science of the University. Thus, arrangements have been

made whereby the Department has transferred on loan to the Laboratory the scientific equipment used in the study and teaching of pathology, bacteriology and parasitology. In return, the demonstration work for students in connexion with these subjects is being carried out at the McMaster Laboratory, and certain lectures and demonstrations are being given by the Council's Parasitologist (Dr. I. Clunies Ross). Further accommodation is provided for Mr. H. R. Carne, Lecturer in Veterinary Pathology and Bacteriology, who, with his staff, is conducting important investigations on behalf of the Division of Animal Health, notably in connexion with caseous lymphadenitis. As is well known the Laboratory is the munificent gift to the Council of Mr. F. D. McMaster of "Dalkeith", Cassilis, New South Wales. Particulars of the building and equipment have been published in the Council's quarterly Journal.

2. *Research Station at Townsville.*—In previous reports of the Council, it has been pointed out that Queensland and Northern Australia generally are responsible for practically the whole of the Australian export of beef and for many of the store cattle which are fattened in southern districts, and that the Council had been urged by many pastoralists of the north to undertake research work on the conditions which militate against the success of their operations. The Council has now made definite arrangements for the investigation of these problems, having availed itself of the generous offer of the Empire Marketing Board to contribute up to £5,000 per annum for five years on a £ for £ basis with local contributions in Australia, and also of the generous offer of the Queensland Government to place at the disposal of the Council its Stock Experimental Station, Oonoonba, near Townsville, and to contribute a definite sum of money annually in order to match part of the funds offered by the Empire Marketing Board.

The Station was handed over to the Council by the Queensland Government in December, 1931, when Dr. A. W. Turner took charge of it. Investigations are now in progress on various diseases of stock such as peg leg disease in cattle, insect borne blood parasites of cattle, walk-about disease of horses and pleuro-pneumonia of cattle.

3. *Pastoral Research Committee.*—In previous reports, reference has been made to the co-operative arrangements made by the Council with the Australian Pastoral Research Trust Ltd. and the Empire Marketing Board. The Pastoral Research Trust agreed to co-operate with the Council in a programme of investigations relating to the health of sheep, and has already allocated a sum of £2,000 per annum for five years for that purpose. The Empire Marketing Board agreed to contribute towards the cost of the work on a £ for £ basis up to a maximum of £3,000 per annum for a period of five years. As a result of these contributions, it has been possible for the work of the Council's Division of Animal Health to be extended materially. Particularly has this been the case in reference to field work in connexion with parasitological research at "Meteor Downs", Queensland, "Gundowringa", New South Wales and "Frodsley", Tasmania, to investigations in connexion with caseous lymphadenitis, to footrot in Victoria, and to pregnancy disease in ewes and pulpy kidney of lambs in Tasmania. An account of the work which is being carried out was published in the Council's quarterly Journal Vol. 3, No. 4, August, 1931.

4. *Black Disease of Sheep* (*Infectious Necrotic Hepatitis*).—One of the outstanding achievements of the Council's Division of Animal Health is the work of Dr. A. W. Turner who has shown that this disease is caused through an infection by *Bacillus oedematiens*, following injury to the liver by young fluke, and has succeeded in preparing a vaccine which has been fully demonstrated to exert a valuable protective influence. The economic value of this work will be realized when it is stated that the estimated annual loss from black disease in Australia is no less than £1,000,000 per annum. The Council has been informed authoritatively that the results of this work will lead to a saving of £100,000 per annum in Tasmania alone, with corresponding savings in other States affected.

The results of the investigation have been published in the Council's Bulletin No. 46. In addition, a popular account of etiology, symptoms, pathology, prophylaxis, &c., has been issued by the Council as Pamphlet No. 10, of which copies have been distributed widely through State Departments of Agriculture and Graziers Associations.

It is satisfactory to report that vaccination with the Turner vaccine is now employed as a routine procedure by the Veterinary Divisions of the Departments of Agriculture in Victoria and Tasmania. During the year 1931–32 over 50,000 sheep belonging to about 50 owners were vaccinated in Victoria, and nearly 100,000 belonging to 100 owners in Tasmania, the results being highly satisfactory.

It is interesting to record that the existence of black disease both in France and in Germany, in all respects similar to that investigated in Australia, save that the associated liver parasite is a different species of fluke, has been definitely determined. The work done by Dr. Turner is, therefore, of world-wide significance.

5. *Gin Gin Disease* (*Enzootic Ataxia*).—Until quite recently this obscure disease which affects young sheep was believed to be confined to lambs at foot on a relatively small area of Western Australia in the Gin Gin district, north of Perth. It has, however, recently been established that it also occurs on one area at Pardelup, near Mt. Barker, a district widely separated from and of a different nature to that originally known to be affected. Apart from field investigations, work during the year 1931–32 was carried out on the clinical, pathological, bacteriological, chemical and botanical aspects of the disease. As a result of the examination of affected lambs from Gin Gin, it was found by Dr. Bennetts that clinically the disease is practically identical with other abnormal conditions of lambs which have been reported from South America, Sweden and Great Britain.

Experiments are being carried out at Mt. Barker in order to determine the possible prophylactic value of salt and phosphate licks fed to ewes during the gestation period and onwards, and at Gin Gin an experimental flock has been placed at the disposal of the Division of Animal. Health. This flock is being used for the purpose of obtaining experimental evidence regarding certain statements made by some sheep owners, and to provide material for pathological and chemical investigation. All available evidence points to the ewes' milk as being the source of the trouble.

6. *Footrot in Sheep.*—Experiments on footrot in sheep have been continued by Mr. D Murnane with head-quarters at the University of Melbourne Veterinary Research Institute. Although the causal agent has not yet been conclusively determined, a great deal of valuable information has been obtained. A number of organisms has been isolated, probably the most common being the necrosis bacillus (*B. necrophorus*) claimed by American investigators to be the true cause. Artificial cultures of each of the organisms isolated have been tested separately on clean sheep with negative results.

Healthy sheep placed with diseased cases during the summer months (*a*) in dry pens, and (*b*) in pens kept continually moist by tap water failed to contract footrot, but healthy sheep placed with diseased cases in pens during winter, when the soil was continually moist through rain water, developed footrot. Similarly when experiments were carried out in the summer on artificial transmission to healthy sheep of the pus obtained from diseased sheep no footrot was developed, but when the same experiment was repeated in winter footrot developed. These experiments were repeated on several occasions, and demonstrated that the disease is infectious, and that moist soil though necessary for its natural transmission is not alone sufficient.

All that can be definitely stated at present is that the disease may be transmitted either by contact or direct inoculation, provided the animals are kept on naturally wet soil during winter months. It may be that the predisposing cause is the lowering of the surface temperature of the hoof and adjacent tissues, or that the responsible micro-organism is readily killed at relatively high temperatures with continuous sunlight.

Mr. H. R. Carne at the McMaster Laboratory has also conducted investigations in connexion with footrot as it occurs in New South Wales.

7. *Haematuria* (*Redwater*) *in Cattle.*—During the year 1931–32 a systematic investigation of this disease was continued by Dr. L. Bull and Mr. C. G. Dickinson at the Government Laboratory of Bacteriology and Pathology at Adelaide.

The results of the investigation will be published at an early date. They have given a mass of information which is of value, but have failed to reveal the etiology of the disease. Future work will be confined almost exclusively to field experimentation, but as the disease is slow to develop in susceptible animals (which are confined to bovines) these observations will have to be carried on over several years before any results can be expected.

8. *Caseous Lymphadenitis.*—Reference has been made in previous Reports of the Council to investigations on this problem which is such a serious menace to the whole of the export frozen lamb and mutton trade. During the year 1931–32 experimental work was conducted by Dr. L. Bull and Mr C. G. Dickinson at Adelaide, Mr. H. R. Carne at Sydney, and Mr. D. Murnane at Melbourne, whilst field observations and experiments were carried out on flocks in New South Wales, Victoria and South Australia.

As regards attempts at immunization, a vaccine prepared by Dr. Bull and Mr. C. G. Dickinson was used in field trials in Victoria and New South Wales on considerable numbers of lambs on properties which from previous experience were known to be seriously affected with the disease. A criticial experiment on lambs which were subsequently artifically inoculated was made near Adelaide. These experiments are not yet complete, but they indicate that it is not probable that a strongly antigenic vaccine can be evolved for the disease.

All evidence in Australia, both from field observations and from experiments, points to wound infection during shearing and marking operations as by far the most important, and that indeed other possible methods are negligible from a practical point of view An experiment carried out in 1931–32 on lambs placed at the Council's disposal by the Australian Estates & Mortgage Coy. Ltd., at a station in New South Wales, definitely incriminated the shearing operations and supported the opinion previously advanced in that direction.

A large amount of work has been done in connexion with studies on infection, the antiseptic treatment of pus, the elaboration of a diagnostic test, studies on toxin production and the disinfection of shearing handpieces.

At a recent meeting of persons interested in the investigation of this disease, it was definitely concluded that a more intensive study of many aspects of the problem cannot be made until a whole flock of infected sheep can be kept under controlled observations. It was agreed that general observations conducted on private properties should be continued as far as possible, and though valuable results may be expected, a complete study of the problem cannot be made in this way. Unfortunately sufficient funds are not available for the purpose of carrying out a large scale experiment on the lines desired.

9. *Pregnancy Paralysis* (*Twin lamb disease in ewes*).—This disease is seen most frequently in flocks of sheep of the mutton producing varieties, though from time to time what appears to be the same condition has been observed in merinos. It occurs just prior to lambing, generally during the last two or three weeks of pregnancy, and though apparently not confined to lambs bearing twin foetuses, is by far the most frequently found in them, hence the popular name.

It has been found that the disease, in common with pulpy kidney in lambs, was frequently reported as existing in flocks in the neighbourhood of Launceston. At that centre, the Tasmanian Department of Agriculture has established a laboratory and a small Experimental Farm at Rocherlea. Arrangements were accordingly made with the Department of Agriculture whereby the Council secured its co-operation in an investigation into these two diseases, its facilities being made available together with the services of Mr. D. T. Oxer, Veterinary Pathologist. The Pastoral Research Committee agreed to finance the investigations from the funds provided by the Empire Marketing Board and the Pastoral Research Trust.

Experimental work with a view to producing healthy conditions in different groups of ewes, such as have been presumed to be predisposing was conducted on three different private properties with the co-operation of the owners, and more exact experiments were carried out at Rocherlea. In the last, four groups of pregnant ewes were employed. Unfortunately no case of the disease appeared in any of these experiments, it being suspected that when they commenced the condition of the animals was in no case sufficiently high. The investigations are being continued.

10. *Pulpy Kidney of Milk Lambs.*—Investigations conducted by Mr. D. T. Oxer resulted satisfactorily in the determination of the actual cause of the disease which has been shown to be due to *Bacillus ovitoxicus* (Bennetts), which is also the casual organism of entero-toxæmia (Braxy-like disease of Western Australia). Thus Mr. Oxer has provided the identity of the two diseases so far as the casual organism is concerned.

The disease is becoming more and more prevalent as the fat lamb industry has developed and is confined to young lambs at foot in excellent condition. The adoption of methods calculated to reduce the condition of lambs during the susceptible period of their lives, a period comparatively brief, has already been demonstrated to be effective. The necessity for routine vaccination is not, therefore, indicated except in the case of valuable stud sheep.

11. *Preputial or Pizzle Disease.*—This disease has been common in Western Australia for a number of years. Affected sheep have been investigated on many different properties whereon the nature of the soil and the class of food is totally different, the latter varying from unimproved natural pasture to rich improved and irrigated lands with clovers and English grasses. So far, there has been no indication that any one particular class of soil or of feed has any predisposing influence. The chief evidence is that the disease is contagious.

Special investigations have been carried out upon affected sheep from various districts. Microscopic examinations indicate the possibility of a filtrable virus being the primary cause of the first sore, visible bacilli being secondary invaders. Further investigations are being prosecuted as cases become available.

12. *Parasitological Problems.*—The investigations at the McMaster Laboratory on parasitological problems have been pursued actively, and have been attended with a considerable measure of success. The work has been carried out under the direction of Dr. I. Clunies Ross who has had the co-operation and assistance of Dr. G. Kauzal, Dr. W. A. Carr-Fraser and Mr. H. McL. Gordon, a Research Student under the Walter and Eliza Hall Trust. Field investigations have been carried out by Mr. N. P. Graham.

In the last Report reference was made to the successful work on the control of kidney worm of pigs (*Stephanurus dentatus*). It was found necessary to repeat certain aspects of the work on the life-cycle of this parasite owing to criticism which appeared in an American publication. Previous findings in regard to the method of skin penetration of the larvae of the parasite were confirmed, and the results of the investigation were published in the Council's Bulletin No. 58.

Progress has been made in the investigation of certain small Trichostrongyles of sheep, and considerable light has been thrown on the pathogenic importance of certain species. An investigation has been made of the life-cycle of the lung worm of sheep (*Dictyocaulus filaria*); methods of treatment for lung worm infestation have been studied, but so far no method entirely satisfactory has been found.

Throughout the year 1931–32 routine examination of sheep viscera at the Sydney Abattoir has been carried out, and much useful information obtained regarding the seasonal incidence of various parasites, their geographical distribution, and the normal degree of infestation of fat lambs.

An investigation of the administration of anthelmintics in licks and drinking water was concluded during the year, and the results published in the Australian Veterinary Journal. No support was found for the administration of anthelmintics either in licks or in drinking water, and it appears necessary to discourage such practices amongst stock-owners. A considerable amount of work has been done in testing the effect of variation in the phosphorus content of food on the effects of parastic infestation, and an investigation has been commenced on the pathogenic importance of certain parasites of sheep.

The field trials initiated at "Gundowringa", "Meteor Downs" and "Frodsley" have been continued, and reports on the results during the first year have been published in the Council's quarterly Journal (Vol. 4, No. 4, page 217, and Vol. 5, No. 1, page 31).

13. *Poison Plants.*—Investigations on certain poison plants have been conducted as follows:—

(*a*) *Whitewood* (*Atalaya hemiglauca*).—Reference was made in the last Annual Report to the investigations conducted by Professor Ewart and Mr. D. Murnane (*see* Council's Bulletin No. 36) in connexion with Kimberley Horse Disease or "walkabout" disease of tropical Australia, by feeding horses on whitewood leaves and seeds. The object of the investigations was to produce the disease in horses far removed from localities where the condition occurs naturally, since it has been claimed by men with practical experience on the one hand that the disease occurs where whitewood is unknown, and on the other, that where whitewood is prevalent the horse disease is unknown. Further feeding tests were conducted during the year 1931–32. The poisonous properties of the plant were confirmed, but with the dried plant material, it was not found possible to produce typical chronic symptoms. The experiments are proceeding.

(*b*) *Caustic Vine* (*Sarcostemma australe*).—A series of feeding experiments has been carried out showing this plant to be highly toxic to sheep and horses. Two ounces of the plant is sufficient to kill an adult sheep. Details of the tests, symptoms and post-mortem findings have been published in the Council's quarterly Journal.

(*c*) *Ironwood* (*Erythrophloem*).—A series of feeding tests with leaves of this tree have proved it to be highly toxic. Details of the experiments are being prepared for publication.

14. *Zebu* (*Brahman*) *Cross Cattle.*—Suggestions have been made to the Council that cross-breeding experiments should be undertaken by it with a view to evolving a type of cattle equally as suitable for a tropical environment as the Zebu, but with the more productive characteristics of the British breeds. Mr. R. B. Kelley, a Research Student under the Science and Industry Endowment Fund, made a special investigation of this matter whilst on a visit to the United States of America. The results of his observations and conclusions have been published by the Council (Pamphlet No. 27). The evidence which he secured strongly supported the desirability of conducting rigorously controlled breeding experiments in North Australia. Owing, however, mainly to lack of the necessary funds and facilities the Council has not yet been able to undertake definite experimental work which would have to be continued over a considerable period of years before any definite results could be obtained.

15. *Export of Pork.*—The possibility of increasing Australia's frozen meat exports by consignments of pork has commanded attention, and at the request of various organizations the Council arranged for a special investigation to be made by Mr. R. B. Kelley during his visit to United States of America. Mr. Kelley's report has been published by the Council (Pamphlet No. 28) and contains a large amount of valuable information. At the request of the Departments of Agriculture in New South Wales, Queensland, South Australia and Tasmania, Mr. Kelley has addressed a number of meetings of those interested in the production of pigs and pig products.

VI. ANIMAL NUTRITION INVESTIGATIONS.

1. *Division of Animal Nutrition.*—In previous Annual Reports of the Council, it has been pointed out that this Division, which is now under the direction of Sir Charles Martin, M.D., D.Sc., F.R.S., was established for the purpose of carrying out extensive and fundamental investigations of problems associated with the nutrition of stock in Australia. For many years to come the work will probably be confined to the study of sheep. The ultimate aim of these investigations is to obtain information whereby sheep living in various localities and climates of Australia may be so fed as to yield the best economic results.

The work of the Division may be divided into—

(i) Experimental researches in the physiology of nutrition.

(ii) Field investigations, the object of which is to assist the pastoralist to overcome difficulties due to climate or terrain, and to carry on his business to the advantage both of himself and the country.

The experimental work in the laboratory and the field investigations are closely interwoven. The questions, the answers to which most interest the grazier are how profitably to maintain on his particular area of country the largest number of sheep, and how to secure the maximum wool clip. Whilst it is realized that the ultimate success of the Division will be judged not so much upon the discoveries it may make in the physiology of nutrition as by the extent to which it can furnish answers to these questions, nevertheless the value of fundamental experimental work must not be overlooked. At any time discoveries in the laboratories may have far reaching applications to practice. Moreover, in attacking practical problems in sheep rearing and wool production, it is just as essential to obtain accurate information regarding pastures as it is to accumulate data regarding the feeding and metabolism of sheep. However complete our knowledge of animal nutrition may become, it alone will not solve problems. Success can be expected only when the agrostologist, the soil chemist and the physiologist collaborate. A welcome step in this direction has been made by the appointment of Mr. A. B. Cashmore, Assistant Agrostologist, to the staff of the Division. The Division of Soil Research has also afforded valuable help. A soil survey has been made of the area at Dismal Swamp where field experiments have been carried out for the past two years, and a similar survey at Kangaroo Island is in progress.

During the past year satisfactory progress has been made in the investigations which the Division is carrying on under the Australian Pastoralists Research Trust-Empire Marketing Board scheme. The object of this work is the determination of the best and most economical methods for supplementary and hand feeding of sheep during drought, and for combating evils attendant on an insufficient amount of phosphorus in the herbage on which sheep are pastured. The work has been facilitated by the completion of an annexe to the Division's laboratory at Adelaide where experiments on the metabolism of sheep are conducted. Its cost was borne by a grant from the Rural Credits Development Fund of the Commonwealth Bank.

Work on the programme previously laid down has been continued. In the laboratory the analysis of grasses and other fodder plants is being continued, particularly with reference to their cystine content. The apparent importance of proteins containing a good supply of cystine to the sheep from the point of view of wool production has been indicated in previous reports mainly in connexion with the field experiments carried out at Meteor Downs, Queensland. A large amount of laboratory work has been carried out on methods for the satisfactory determination of cystine. Special attention has also been given to methods for the estimation of the rate of growth of wool over short experimental periods. For many purposes it is essential to have such a measure, and it has now been found that the amount of wool grown over as short a time as six days can be estimated with considerable accuracy by shaving small areas of the skin before and after the experimental period and weighing the wool after it is cleaned of extraneous matter.

A large amount of work has been carried out on the sulphur and phosphorus metabolism of sheep and on the distribution of phosphoric acid in the various parts of the animal. This matter is of considerable practical importance in connexion with experimental work on areas in which the sheep are known or suspected to be suffering from phosphorus deficiency.

Further work on the amount of iodine in the thyroid glands collected from sheep in various parts of Australia has confirmed the results obtained previously, and has indicated that there is generally no insufficiency of iodine in the pastures. The results of the investigation, which is the joint effort of the Division of Animal Nutrition and the Animal Products Research Foundation of the University of Adelaide will be published in the Australian Journal of Experimental Biology and Medical Science.

Another investigation carried out relates to the basal metabolism of sheep, which constitutes a fundamental piece of knowledge necessary for estimating the food requirements of sheep. The results have been published in the Council's Bulletin No. 55 entitled " The Basal (Standard) Metabolism of the Australian Merino Sheep ". The practical importance of this work lies in the fact that the basal metabolism being known, the minimal amount of energy-producing food required to keep the animal alive during periods of drought, when the natural pasture is exhausted, can be determined, and with the data available as to the energy contained in different foodstuffs, their digestibility and their price, the cost of the most economical hand feeding can be calculated.

Other investigations in progress in the laboratory include the effects following the removal of the thyroid and pineal glands from the sheep ; the growth of wool on a diet deficient in cystine ; the effect of continuous phosphorus deficiency on sheep receiving a diet adequate in other respects ; the daily intake of phosphorus necessary for phosphorus balance in the sheep and the role of salivary phosphate in the digestion of food by sheep. The work on the removal of the thyroid gland indicates that in older sheep complete removal of the gland has little visible harmful effect, though the wool fleece grown is reduced in quantity and has a harsh, dry appearance. The animals from which the pineal glands were removed sustained their remarkable fleece-producing capacity referred to in the last Report. It seems that the pineal gland functions as an internally secreting gland, and that when the influence of its secretion is removed in the sheep, the animal is able more efficiently to convert ingested protein into fleece. It is yet to be determined how this change is brought about. It is realized, of course, that it would be quite impracticable to operate on any considerable number of sheep in this way, but the fact remains that it has been found possible to increase the yield of wool per animal by from 40 to 80 per cent., and further work may indicate a way in which this can be done on a practical scale.

The various small field stations which have been set up in co-operation with several owners of sheep stations serve the dual purpose of enabling results obtained in the laboratory to be tested on a practical scale and of drawing the attention of the laboratory workers to practical problems in the field. Work has been continued at " Niawanda " near Beaufort, Victoria, for the purpose of ascertaining the influence of manuring a pasture with sulphur upon the growth and wool-producing of sheep grazed on it ; at " Meteor Downs ", Central Queensland, where the effect of adding proteins to the diet of the sheep is being studied and where an increase of 30 per cent. in the wool yield per animal has been obtained ; at " Hawk's Nest ", Kangaroo Island, South Australia, where the Australian Pastoral Research Trust and Empire Marketing Board work on phosphorus deficiency is being conducted ; and at " Wambanumba ", Young, New South Wales, where the response of the pastures in terms of wool to manuring with sulphur, nitrogen and phosphorus is being examined. The work at the field station at " Dismal Swamp " near Mount Gambier, South Australia, where the effect on the sheep of different forms of phosphatic licks was under investigation was suspended in the summer last year mainly owing to disease, infection with stomach worms and footrot occurring among the animals. The field station at " Keytah ", Moree, New South Wales, where the effect of adding iodides to licks was under test, was also closed during the year, previous years' work having shown that there was no reason to believe that a deficiency of iodine existed.

At " Meteor Downs ", where earlier work had shown that an increase of 35 per cent. in the wool yield per animal could be obtained by adding two-thirds of an ounce of sterilized blood meal to the daily diet of the sheep, an experiment was started in order to determine whether the increased yield was determined by the cystine content of the supplementary ration or whether the extra protein or calories were responsible for the result.

To test this, the two supplements chosen each to be fed to a group of 100 lambs were (*a*) dried yeast containing about 3 per cent. of cystine, and (*b*) commercial casein containing only about 0.32 per cent. of cystine. Both supplements contained the same amount of nitrogen and phosphorus.

Unfortunately severe drought occurred after the experiment was started and the pasture became inadequate. Both groups had therefore to be given a daily ration of 2 oz. maize during four months of the year. This addition was not enough to support a normal rate of growth and the wool-clip at the end of the year was a small one. The average greasy wool produced by the group receiving a little more than ½ oz. of yeast daily was 57.8 oz., and that cut from those having a similar quantity of protein in the form of casein 50.1 oz. an increase in favour of yeast of over 15 per cent. The results of the first two years' experiment at Meteor Downs have been published (Bulletin No. 61 entitled " Studies in the Supplementary Feeding of Merino Sheep for Wool Production ").

2. *Mineral Content of Pastures.*—A series of investigations relating to the mineral content of pastures has been carried out as a co-operative enterprise by the Empire Marketing Board, the University of Adelaide and the Council, the work being centred at the Waite Agricultural Research Institute, under the direction of Professor A. E. V. Richardson.

The original objectives, as approved by the Empire Marketing Board, included the yield and composition of pastures in minerally deficient areas, the role of phosphorus in pasture production, factors affecting the mineral content of pastures, factors affecting the water requirements of pasture plants, and the determination of the most economical methods of alleviating pasture deficiencies.

As practically the entire sheep and cattle population of the Commonwealth is maintained on indigenous and induced pastures, and as in consequence grass must be regarded as Australia's most valuable crop and outstanding source of wealth, the importance of this work is obvious.

During the past two years a number of reports dealing with various aspects of the work has been published by the Council. The first of these (Pamphlet No. 18) deals with the influence of the frequency of cutting on the productivity, botanical and chemical composition and nutritive value of natural pastures in southern Australia. Bulletin No. 49 deals with the factors affecting the mineral content of pastures, with particular reference to localities where alternating periods of winter rainfall and summer drought prevail. Under these conditions it is shown that it is possible to increase the output of grazing animals by making use of three interdependent principles, namely: (1) the establishment of persistent species (and strains) capable of assimilating essential nutrients over an extended period of the year, (2) the efficient utilization of herbage by satisfactory systems of management, and (3) the maintenance of soil fertility by the application of suitable fertilizers. Bulletin No. 48 deals with the experimental error of the yield from small plots of natural pasture and is of value most particularly to scientific investigators.

The effect of growth-stage and frequency of cutting on the yield and composition of a perennial grass, *Phalaris tuberosa*, is dealt with in Bulletin No. 66. Growth-stage was found to exercise a determining influence on the composition of *Phalaris tuberosa*, especially on the protein, crude fibre, and mineral content. A downward migration of nitrogen and phosphoric acid occurred in this plant from the herbage to the basal internodes and root system. It was found that, during the final stages of growth, potash was lost to the soil in considerable quantities from the herbage, basal internodes and roots.

The yields of all portions of the plant were found to be reduced considerably with increased frequency of cutting, and the root system was affected to a greater extent than the above-ground portion of the plant. Taking into consideration the yield of dry matter, production of nutrients, and the permanence of the plant in a semi-arid environment, three cuttings or grazings each season led to optimum results.

In addition to the above reports, papers have appeared in recent issues of the Journal of the Council dealing with the role of pasture species in regions of winter rainfall and summer drought, the rate of growth of a South Australian merino fleece, investigations of indigenous salt bushes, and the relation of mineral ions to transpiration. A paper on the improvement of *Phalaris* species by selective breeding also appeared in Bulletin No. 7 of the Imperial Bureau of Plant Genetics: Herbage Plants, and an account of experiments on the top-dressing of natural pastures with artificial fertilizers over a period of seven years was published in the South Australian *Journal of Agriculture* for July, 1932.

Two further reports, to be issued as Bulletins of the Council, are at present in the press. The first deals with the seasonal productivity and botanical composition of irrigated sown pastures under varying systems of pasture management, and the second with the taxonomic and agricultural characters of the *Danthonia* group.

The investigations have shown definitely that while the environment exerts an important influence on the mineral content of each plant species, there is a limit to the ability of plants to make use of available plant nutrients, which is imposed by the nature of the species itself. It is also shown that the most economic method of overcoming the mineral deficiency problem on arable land, in regions of moderate rainfall, is to replace the "natural" pasture with perennial species and strains adapted to the soil and climate and to maintain their productivity by suitable top-dressing and management. For these reasons work on pure species, strain variation within the species, and pasture management in representative areas of the winter rainfall zone have been regarded as a necessary part of the mineral deficiency investigations. This extension of the scope of the original investigations has opened up promising lines of work on grassland improvement in the winter rainfall zone of southern Australia.

VII. SOIL INVESTIGATIONS.

1. *General.*—The Division of Soil Research is located in the Melrose and Darling Laboratories of the Waite Agricultural Research Institute under a co-operative agreement with the University of Adelaide. The main objects of the Council's soils investigations are two-fold, viz. :—

(*a*) To provide a centre for the systematic investigations of Australian soils and soil problems in order to provide a fundamental basis for the advisory work of the State Departments of Agriculture and for the developmental and executive work of the Departments of Lands, Irrigation and Forestry.

(*b*) To make soil surveys of virgin areas for future settlement and development, and of such recently settled areas as present problems of immediate importance and which may provide a groundwork of information for further settlements of a similar character.

Losses incurred in land settlement schemes, particularly on certain irrigation areas, due largely to lack of fundamental information regarding soils, amount to a very large sum of money, and the results of the work of the Division of Soil Research indicate clearly not only that much of the loss could have been avoided had the necessary soil investigations been made, but also that future developments in irrigation settlement can be undertaken with a full knowledge, so far as suitability of soils is concerned, of the conditions essential for successful production.

In addition to benefiting the settler by furnishing him with authoritative advice as to methods necessary to increase production, the Division has already been able to afford valuable assistance with respect to new settlement projects. An example of this is the investigation of the soils on the bed of Lake Albert, at the mouth of the Lower Murray. As a result of that investigation it was shown that the project was likely to be unsuccessful, and it was accordingly abandoned. In this way, the saving of a large sum of money, which would otherwise have been largely wasted, was effected.

2. *Soil Surveys.*—The work of the Division has been directed primarily to investigations of the more closely settled and more valuable lands, namely, the irrigation settlements. The task of surveying is divided into convenient units, each capable of being covered by a field party in the course of six months or less. With each survey unit a chemical group is usually associated and during the year the co-operation of the chemical staff of the Victorian Department of Agriculture is warmly acknowledged in connexion with the surveys on the Victorian settlements. The completion of these surveys in the irrigation areas may be considered to be a settled policy of the Division, but during the year surveys in other areas have also been carried out.

Not only was the area surveyed during the year 1931–32 the largest aggregate area for any year since these surveys began, but the area surveyed in that year in irrigation settlements alone was larger than the total area surveyed in any previous year.

The survey of the Cadell Settlement, South Australia, referred to in the last Annual Report of the Council was completed by Messrs. T. J. Marshall and N. J. King, and the results have been published as a Bulletin (No. 62) of the Council. Information of considerable value from the point of view of the control of waterlogging and salt accumulation has been obtained.

The survey of King Island by Messrs. C. G. Stephens and J. S. Hosking, carried out at the request of the Tasmanian Department of Agriculture, in order to provide a basis for its advisory work in crop and pasture production and in veterinary work, has been completed. A report on this work is now in the press prior to publication by the Council. Eight soil types were defined and named in addition to the recognition of a number of miscellaneous types. The association of " coastiness " in stock with Currie calcareous sand is the most remarkable feature of this survey, but apart from this problem the data obtained will enable the development of pastures to proceed on a scientific basis. Mr. A. E. Scott, an officer of the Waite Institute, has been associated with the survey work and has secured representative pasture samples for laboratory examination which is in progress.

Messrs. J. K. Taylor and J. O'Donnell have reported the soil survey of the Hundred of Kuitpo to the Royal Society of South Australia. This area, which is within easy reach of the Division's Laboratory, has been used as a training ground for new soil surveyors for systematic surveys during the summer months. Soil surveys were carried out on two field stations of the Division of Animal Nutrition, namely, " Dismal Swamp " and " Hawk's Nest ", Kangaroo Island ; a laboratory examination of the soils from this latter is being carried out and the Division of Soils will maintain a close association with the nutritional investigations at this field station.

A soil survey of a group of irrigation settlements near Swan Hill, Victoria, has been completed. These include—

Nyah	4,000 acres.
Tresco	3,500 acres.
Tresco West	1,200 acres.
Kangaroo Lake	700 acres.
Murrabit	600 acres.
Bungunyah (New South Wales)	500 acres.
Goodnight (New South Wales)	300 acres.

This work was carried out by a team of workers including Messrs. J. K. Taylor, T. J. Marshall and P. D. Hooper of the Soils Division and Messrs. F. Penman and G. W. Leeper of the Victorian Department of Agriculture and University of Melbourne, respectively. The detailed mapping, description and laboratory examination of soils from these areas has been completed and a report is in course of preparation. Five soil types have been recognized. It is anticipated that the soil survey of the whole of the irrigation settlements in the Murray River Valley will be completed in about two years' time.

The first extensive survey in association with a State Lands Department was carried out during the early part of 1932. This involved the survey of 290 square miles of virgin territory in what is popularly known as the " ninety mile desert " of South Australia. The Hundreds of Laffer and Willalooka are typical of a much larger area and present a number of soil features which makes their possible development a considerable risk unless more information can be obtained regarding the character of the soils. The Hundred of Willalooka which abuts the settled areas south of Keith and those of the Tatiara west of Bordertown was quite unsurveyed, and the co-operation of the Royal Australian Air Force was obtained and preliminary key runs photographed on which to base the actual aerial photographic survey. Two soil types of importance were defined as well as a number of less important types. The field work was carried out by the Divisional survey staff in association with Surveyor C. P. Melville of the South Australian Lands Department. A large number of representative soil samples have been collected and are being examined by Mr. H. G. Poole.

The preliminary soil maps have been completed and have been made available to the South Australian Government.

In the Murrumbidgee Irrigation Area, Mr. H. N. England has concentrated his activities on the investigation of water logging problems under the direction of Mr. F. K. Watson of the New South Wales Water Conservation and Irrigation Commission, to which Commission he has been seconded for a period. Laboratory work on the rice soils of this area is proceeding and is in the hands of Mr. A. Howard (formerly chemist to the British Australian and New Zealand Antarctic Expedition).

On the completion of the work on King Island, in consultation with the Tasmanian Department of Agriculture it was agreed to concentrate soil work on a general survey of the main soil zones of Tasmania and to carry out a survey of the hydrogen ion concentration and lime requirements of Tasmanian soils. As there has been much advocacy of the use of lime in this State, it was highly desirable that any extension in the use of lime should have a more rigid scientific basis than had been available in the past. In addition an assessment has been made for the Forestry Department of the soil conditions in certain areas which have proved unsatisfactory for the growing of *Pinus radiata* (*insignis*). This Tasmanian work has been carried out by Mr. C. G. Stephens, having his headquarters at the University at Hobart.

3. *Laboratory Investigations.*—Apart from the systematic examination of soils associated with the above-mentioned surveys, a number of investigations has been in progress, chief of which have been the examination of a large number of representative soils for moisture equivalent and sticky point by Mr. H. G. Poole in association with the Chief of the Division. The correlations between mechanical analyses and these soil moisture constants have been examined and the effect of organic matter and the nature of the exchangeable bases has been investigated. Mr. C. S. Piper, of the University staff, has examined a range of soils from sub-antarctic islands collected by Sir Douglas Mawson during the recent British Australian and New Zealand Antarctic Expedition in the Discovery, as well as a range of soils used for the preparation of turf wickets in Australia. During the past few years, a large number of soils have been collected from localities in the South Australian mallee and a statistical summary of the laboratory records of these samples by Professor Prescott and Mr. Piper is in course of preparation. The work of Miss P. Rountree, a research student, under the Science and Industry Endowment Fund, on the biological oxidation

of sulphur in an infertile soil from the Renmark Irrigation Area, has shown that sulphur is very rapidly oxidized, but the organism or groups of organisms responsible for this process have proved difficult of isolation ; biological work is in progress on nitrate fluctuations in soils in continuation of previous work of the Division.

Mr. R. J. Best has continued his investigations on the standardization of methods for the determination of hydrogen ion concentration, and Mr. Piper has standardized the triple uranyl acetate method for the estimation of sodium in soil extracts.

VIII. IRRIGATION SETTLEMENT INVESTIGATIONS.

1. *General.*—In previous Annual Reports of the Council, attention has been directed to the importance of research work aimed at the improvement of methods of production in the Irrigation Settlements. The dried fruit industry of Australia has an annual turnover of nearly £3,000,000, and the citricultural industry has led to the establishment of many thousands of homes in the irrigation areas, and to the expenditure of large sums of money on dams, channels, pumping stations, &c. Investigations have been undertaken by the Council on problems relating to dried vine fruits and citrus fruits which constitute the main production of the settlements. In addition the Council is carrying out investigations on the soils of the areas, but particulars of that work have been given in a preceding section of this Report, relating to soil problems.

2. *Commonwealth Research Station, Merbein—Viticultural and Irrigation Investigations.*—

(i) *General.*—Investigations into problems associated with the production and drying of grapes, and the irrigation of the land on which they are grown are in progress at the Commonwealth Research Station, Merbein, under the direction of a Committee of Control. Mr. A. V. Lyon, the Officer-in-Charge of the Station, is specifically engaged on investigations of viticultural and irrigation problems, and, at the request of the industry, is also associated with measures for initiating improvements in routine practices. Mr. J. E. Thomas is the chief agricultural officer of the Station, his major problem being a comprehensive investigation of the occurrence of injurious salts and their distribution resultant on irrigation.

(ii) *Processing of Dried Fruits.*—Investigations of methods of processing dried fruits have been undertaken, in the endeavour to produce a product more generally suitable to the overseas market. During the past two years, the investigation was extended to test the application of the Station's methods to other districts where soil, climate and general environment differed materially. In semi-commercial trials of this nature, the work was carried out with the co-operation of State officers concerned, and under the direction of the Fruit Processing Committee. This Committee which was formerly known as the Committee on the Sulphuring of Dried Fruits was set up by the Council some time ago and is representative of the Council and of the States of New South Wales, Victoria and South Australia. Its present functions are to initiate research at existing Federal and State institutions on urgent problems connected with dried fruits, and to issue joint recommendations for the purpose of securing uniformity in processing and packing methods.

The Committee has standardized the methods of drying grapes and sulphuring apricots, and commercial results have indicated, as a result of this work, a greater uniformity and a higher standard in the export pack.

For the information of primary producers and packers, reports and recommendations on the routine work of producers including the methods of processing sultana grapes, the field and factory operations affecting keeping qualities, and the methods of sulphuring apricots, have been issued.

(iii) *Control of Dried Fruit Pests.*—Acting in conjunction with the Department of Commerce, steps have been taken to ensure, by regulations devised to prevent infection, and regular inspections of packing houses, &c., that the infestation of dried fruits by entomological pests is kept at a minimum. The results have been extremely satisfactory, the present position being that the pests are kept in check to the extent that practically the whole export pack is successfully marketed. A further refinement, namely, the development of insect proof containers to give absolute protection is now being investigated in co-operation with the Division of Forest Products.

(iv) *Irrigation Investigations.*—The steps taken to reduce the unnecessary applications of irrigation water to River Murray soils have been extended. An advisory pamphlet, dealing with frequency and methods of irrigation, has been published (*see* the Council's Pamphlet 24) and the suggested improvements are being brought about with the co-operation of the irrigation authorities concerned. Intensive research into irrigation methods and soil moisture requirements is in progress on defined soil types in the Merbein (Victoria) and Renmark (South Australia) irrigation settlements.

At the request of the viticulturists and the respective irrigation authorities, the work of initiating improvements in additional settlements is being extended as rapidly as staff facilities and opportunity permit. Irrigation investigations have become a major activity of the Station, and it is established that economy in water distribution is accompanied by a greater efficiency in crop production, as well as preservation of soil fertility which otherwise may become impaired by accumulations of injurious salts.

(v) *Plot Experiments—Application of Fertilizer.*—Field trials have been commenced for the purpose of studying the technique of field plot experiments under irrigation conditions. Preliminary studies of the yield variability of vines have been carried out, the plots being planned on the "Latin square" principle, with sufficient vines in each unit and a sufficient number of replications to permit of a statistical analysis of the results.

(vi) *Viticultural Studies.*—The study of vine growth, fruiting habit and the effect of routine operations in the vineyard has been continued and extended. This work is correlated with the frequency of irrigation in relation to the growth and maturity of shoots and fruit and with viticultural operations as they affect yield and quality. Interim reports are made available to producers. The results of the researches indicate that a change in routine methods is beneficial.

(vii) *Salt Investigations.*—Investigations into salting of soils are in progress on an intensive scale on a virgin field specially selected for this purpose. Detailed contour, ecological and salinity surveys were completed prior to planting. It was found that a high and irregular distribution of injurious salts existed throughout the area in its virgin state. The vines have now been established, the land regularly irrigated for one year and the effect of the first season's irrigations on the salts determined. The results are extremely important, in view of the fact that irrigation methods hitherto adopted in Australia have resulted in wastage of potentially salty lands as irrigation proceeds. The data secured indicate that, if the minimum efficient applications of irrigation water are employed, the fertility of the land as affected by injurious salts can be maintained or improved by leaching the injurious salts beyond the region of root establishment. The incidence of salt, as affected by agricultural drainage, methods of irrigation, and the quantity of water used, is also being investigated, and is being correlated with the growth and development of the vines.

(viii) *Assistance from the Dried Fruits Industry.*—It is encouraging to report that the dried fruits industry has recognized the commercial value of the above researches by a very generous contribution of £1,000 a year for two years to the funds of the Merbein Station. These funds are granted by the Dried Fruits Exports Control Board and are being used for urgent investigations likely to give immediate results, and for technical advice to primary producers' organizations in cases where a preliminary examination of existing methods indicates the probability of effecting improvements. In addition a small fund (£60 per annum) has been contributed to the Council by local growers concerned for certain investigations in the Nyah and Woorinen (Victoria) districts; and other organizations and many individuals engaged in the dried fruits industry have exhibited a pleasing readiness to afford facilities for research, in personal assistance and material, in all cases where co-operation has been sought.

3. *Citricultural Investigations.*—Steady progress has been made along the lines of the experiments laid down at the Council's Research Station at Griffith in the Murrumbidgee Irrigation Area of which Station Mr. E. S. West is in charge. The investigations are being financed jointly by the Council and by the New South Wales Water Conservation and Irrigation Commission. The main investigations at the Station concern:—

(*a*) the effect of different soil treatments on yielding capacity and other properties of the soil;
(*b*) the most profitable fertilizer treatment for citrus fruit;
(*c*) the effect on soil and citrus trees of various methods of green manuring.

Field experiments have shown that citrus yields can be profitably increased by the use of winter green manure crops and by nitrogenous manures, and these treatments are now becoming the standard practices on the area, with consequent increase in productivity and reduction in production costs.

Investigations concerning soil moisture have yielded important information which will go far towards the improvement of irrigation practices. It has been found that lucerne withdraws moisture rapidly from the soil and from depths as much as 10 feet. The withdrawal of moisture from the soil by citrus, however, is confined to the surface 2 feet. This corresponds with the root zone of the respective plants, and explains why salt accumulation and high water tables are so common in irrigated citrus soils. With prevailing methods of irrigation a large amount of water percolates below the root zone and saturates the soil. It is, therefore, necessary to use entirely different methods for the effective irrigation of these crops. It is found that lucerne

can be used to withdraw excess moisture from water-logged soil, and for intercepting seepage from higher land or leaky ditches, and for these purposes is cheaper and more effective than tile draining. It, however, should not be planted in orchards as it keeps the soil too dry. The effect of weather factors such as rain, evaporation, temperature and atmospheric pressure on the water table of the soil has been studied. The atmospheric pressure and soil temperature markedly affect it. The water table responds to small changes in the atmospheric pressure; but the effect of soil temperature, though marked, is more seasonal in its effects, causing the water table to rise in the early summer and recede in the early winter. Contrary to generally accepted ideas, the effect of evaporation from the surface of the soil, without the medium of the plant, is very limited. The water table has very little relation to the moisture content of the soil beyond a distance of about 2 or 3 feet above it, so that the determination of the height of the water table alone may give misleading ideas of the moisture content of the soil. As a result of the soil moisture investigations at the Station, settlers are paying more attention to their irrigation methods, and there are already definite signs of improvement in the general practice, though there is still much more room for improvement and a big field for investigation.

It has been found that the soil mulch produced by cultivation keeps the soil 3 degrees Centigrade cooler during the summer than uncultivated soil. The effect is apparent to as much as 2 feet, at which depth the temperature in " mulched " soil was maintained 2 degrees cooler than in the uncultivated soil during the summer.

Further to the investigations already recorded concerning the effect of mallee scrub on the incidence of frost, where it was shown that the presence of mallee scrub caused excessively severe frosts in and near it, it has been found that with the removal of the mallee the minimum temperatures recorded are not now excessively low, this being a direct confirmation of previous findings. As a result of this investigation it has been possible, by clearing the mallee, to increase greatly the value of a large and important section of the irrigation areas for irrigation purposes.

The tendency on the irrigation areas of Valencia oranges to alternate cropping which is becoming a serious problem owing to the consequential marketing difficulties, is being investigated in co-operation with the Division of Plant Industry.

IX. FOREST PRODUCTS INVESTIGATIONS.

1. *General.*—The year 1931–32 has been one of continual expansion of activities and of very definite progress towards the solution of some of the many problems of the timber industry that are being studied. Some temporary relief has been given to the crowded condition of the laboratories and workshops by the addition of four extra rooms, and by the erection of a large timber workshop and shed, and also by roofing over the yard. This work has been carried out and the machinery installed by the Division's staff. The shed building, 40 feet by 20 feet which contains rooms for the headquarters overflow library and the Section of Food Preservation, besides a store and a large room for the drying and storage of timber under investigation, was erected by the Division on a design based upon its belief in the advantage of Australian hardwoods. Use has been made of the higher strength properties of these timbers and dimension of the members reduced accordingly. The building is an example of extremely cheap and efficient construction and is built throughout of second grade timber to show how favourably this compares with imported softwoods. It is hoped that many architects and builders will have an opportunity of inspecting this building.

The State Departments have not developed utilization branches to any extent and the greater part of all such work necessarily falls on the Council's Division of Forest Products. An extensive correspondence is carried on in advisory work with the State Services and individual millers or users of timber in all States. The lack of personal contact except by means of occasional hurried visits makes the work of this important section very difficult at times. Individual members of the staff should travel a great deal more than is possible on the existing budget.

During the year the Division has had a continuation of most effective assistance from the Forest Products Laboratories of England, Canada, United States of America, Africa and India. The readiness with which all these Laboratories supply copies of internal reports of their researches is heartily appreciated. Such interim reports are of the greatest value. Samples of timbers for the Division's collection have also been received from Burma, China, Argentine and England.

The large timber-using public bodies are steadily increasing their demands on the Division. In return they give every assistance to it in carrying out its inquiries. Co-operative efforts are in progress in conjunction with the Victorian Railways, the Victorian State Electricity

Commission, New South Wales Public Works Department, the Postmaster-General's Department, the State Saw-Mills of Western Australia and South Australia, the Melbourne and Metropolitan Tramways Board, the Victorian State Rivers and Water Supply Commission and the Commonwealth Department of Commerce.

Close co-operation has been established with the South Australian Department of Woods and Forests in connexion with the technical side of its important operations on *Pinus radiata* in the south-east. Officers of the Division have frequently visited the mill and reported on its working.

The associations of saw-millers and timber merchants in all the States are also freely co-operating in the work and they show their appreciation of the value of research to their industry.

Progress has been made in 64 major and 22 minor projects during the year, and a number of publications has been issued.

One of the outstanding features of the year has been the sale of the experimental tannin extract plant in Perth to a Western Australian commercial concern which has re-erected the plant and begun the commercial production of extracts from waste karri and marri barks. This manufacture is based on the results of the researches of the Division and is a gratifying conclusion to years of experiment. It is expected that the industry will develop an extensive export trade.

A second important result has been the bringing to a successful issue of the research into the prevention of wood taint in butter. The method of spraying with a solution of casein and formalin has been developed and improved and tested out in a practical way. With the co-operation of the South Australian Farmers' Union a shipment of 90 boxes of butter packed in cases of *Pinus radiata* was sent to London. This timber was selected as it invariably and quickly taints butter very badly. The shipment was successful and has given satisfaction to the butter experts in London and Australia, who were interested. Such criticism as was made was mainly directed to the construction of the boxes which were unfortunately of undressed timber and not as well manufactured as could be desired. The condition of the butter, however, was excellent except in five boxes out of 90. In these cases there was a slight taint on the top edges only, and the reason for this has been apparently found and will be removed. The South Australian Farmers' Union was so satisfied with the result that it has agreed to send a series of further shipments. One of these has already gone, and the boxes for further shipment will shortly be prepared. A shipment of 300 sprayed hoop pine boxes, together with a similar number of controls, has also been made at the request of Queensland interests. Except for the worst quality hoop pine, which is never used for butter boxes, the method has been uniformly successful and will doubtless be extensively used in the near future. It will result in a large saving to the butter industry and in the use of local instead of imported pine for our butter export boxes. The funds for this work were provided by the Australian Dairy Council. The details of the process have been given in the Council for Scientific and Industrial Research Journal. The process has been covered by patent to prevent its exploitation by private interests. When the experimental shipments are complete steps will be taken to licence box makers to use the process.

A third feature of great interest has been what appears to be a definite promise of the early establishments of the paper industry in Tasmania, using local hardwoods. For some years two companies have had proposals for beginning this important industry, but the difficulties of finance seem so far to have proved insurmountable. Within recent months a third company has been formed and a new concession taken up in the Florentine Valley. This area is particularly rich in supplies of *Eucalyptus regnans* which is the most suitable of the eucalyptus for making mechanical pulp for newsprint. The Tasmanian Parliament has passed the necessary legislation and a start is to be made at once. The coming year should see the plant installed and at work. It is particularly pleasing that, as the result of the work carried out under the Council for Scientific and Industrial Research and its predecessor, the Institute of Science and Industry, and as the further result of many years' patient work and propaganda, to persuade financial interests that the process evolved was practical, this most important industry will be begun. Researches began in 1916 under the present Chief of this Division and reached the semi-commercial scale some years ago. It was at first almost impossible to get acceptance of the idea that hardwoods could be used. The second battle was to persuade those interested that the small scale results could be repeated commercially. The third stage was the establishment of the soundness of the economics of the proposals. Each of these difficulties has been overcome and the Council and this Division can be legitimately proud of its share in laying the foundations of what is destined to be one of the largest and most important industries in the Commonwealth.

2. *Equipment.*—During the year important additions have been made to the equipment of laboratories. Owing to a generous donation by the Commonwealth Bank Board the Division was able to instal a third experimental kiln, a box testing drum, a toughness tester and a Universal testing machine. These machines are already proving of great value and have given results which are reported below and which are capable of immediate application. In addition, the wood-preservation cylinder has been extended to allow the treatment of full-size sleepers.

3. *News Bulletin.*—A further means of broadcasting information of value has been started during the year and is proving a great success. A monthly news bulletin is issued to Forest Services, and associations of millers, architects, builders and a large and growing number of individuals, and also to a great number of town and country newspapers and trade journals. The latter publish these monthly notes fully, and in this way a very large public is reached. The Bulletin consists of short informative notes on general timber problems and the results of researches carried out in Australia and abroad. The rapid growth of the demand for the bulletin and trade circulars which continue to be issued, and the expressions of thanks from a wide public show how valuable are these methods of popularizing the practical results of research.

4. *Seasoning Class.*—At the request of the Victorian Forestry Commission and many saw-millers and merchants, a week's class in seasoning was held at the Division's head-quarters in May. There were 35 attending the class, two of whom came for purpose from Tasmania. The work consisted of lectures, practical work and demonstrations on commercial kilns. At the conclusion of the class, the members expressed their appreciation of the value of the training they had received. Only the question of cost has prevented the extension of these classes to other States. It is hoped that in the coming year they can be held at least in New South Wales and Tasmania. The value of such classes in the extension of good practice in seasoning is most evident and is reflected in the large attendance at this year's class.

5. *Utilization.*—A definite Section of Utilization only became possible on the return of Mr. R. F. Turnbull in November, 1931. In the part of the year that it has been in existence a beginning has been made in a number of useful studies.

Numerous visits were piad to factories utilizing wood, and a large volume of useful information collected and systematically recorded. Inquiries were also made in response to requests from manufacturers into the use of timbers for battery separators, boot lasts, coat hangers, tallow casks, lead pencils, rifle stocks, rat traps, tobacco pipes, tool handles, toys, wood-wool and the disposal of factory waste.

A report on the economies of the manufacture of wallboards has been prepared and will shortly go to press. This industry is rapidly growing abroad, especially in the United States of America and offers great possibilities in promoting more efficient utilization of timber. Like the paper industry, however, it needs large capital expenditure and a close study of the economics of the industry is essential. The publication of the report will provide a basis for such study by those interested.

At the request of the South Australian Department of Woods and Forests, a visit was paid to Mt. Burr. A report was prepared on the detailed working of the gang saw-mill and accessory plant at Mt. Burr, and recommendations made for its most efficient operation.

This Section is designed to put into operation the results of the investigations of the other Sections of the Division, and should, if funds permit, be considerably expanded as soon as possible.

6. *Standards.*—The work in connexion with the standarization of timber and the establishment of grading rules is practically controlled by the Division's Section of Utilization, working under the Standards Association of Australia through a number of State Committees and a Central Committee in New South Wales. The Chief of the Division acts as Chairman of the Standards Committees. Good progress has been made in this difficult field. The existence of different practices in each State, which have become hallowed by long usage, renders the task of getting agreement very difficult. It has taken two years to get such agreement on a glossary of terms. This, however, is now complete and has been adopted tentatively for all Australia.

The second step taken was the establishment of grading rules for flooring. Most of the States have completed the first step in this, and it is hoped shortly to prepare a preliminary draft.

At the request of the Standards Association the question of standardizing export fruit cases has been begun. A special Committee of the Association has been formed and definite progress has been made. It was decided to confine the work at first to apple cases. The existing information was so conflicting that it was further decided that the Division should carry out

experimental work to establish the necessary facts. This work was carried out jointly by Mr. W. M. Carne, of the Division of Plant Industry, and Mr. R. F. Turnbull. The work for this season, owing to the short time available, had to be restricted to experiments to develop suitable technique. These experiments are complete and have brought out facts of considerable importance. The basis is now laid for a comprehensive series of tests in the next apple season. It is expected that when practical large-scale tests have established definite facts to replace the existing conflicting opinions, there should not be any serious difficulty in reaching a decision on this vexed question. The shipping companies and railways are very definite in their statements of the losses caused by the lack of standards and they are co-operating freely in the work.

7. *Wood Structure.*—The main project in this Section has been the development of a key for the indentification of a group of 37 species of coloured eucalypt timbers. This has been completed and a tentative key evolved. The report covering this work is now in the press and will shortly be issued. It is the first step in the development of a general key for Australian timbers and will finally be issued in the form of a timber map for Australia. This will be of undoubted practical value especially when it is extended to cover a wider field. An attempt is being made to use the simplest possible methods of separation and chemical tests are developed to assist in difficult cases. At present a study of the pale coloured eucalypts is in progress. The whole project covers some hundreds of thousands of measurements and the preparation of many thousands of misroscopic sections. During the year over 400 samples were sectioned, 730 were examined macroscopically, 500 were examined microscopically and 75 photomicrographs prepared. Authentic samples from 550 trees have been added to the timber collection during the year.

The study of the densities of Australian timbers is being rapidly extended. The method used was developed in the Division and has been described in Pamphlet No. 21 (D.F.P. Technical Paper No. 2). It marks a distinct advance on older methods in that it overcomes the difficulty due to irregular shrinkage or collapse, which can be the cause of very large error. During the year 720 density determinations were made. So far the full number of samples of some 70 timbers have been examined for this property and many others are partly determined.

A further study has been that of the variations in physical properties throughout a tree. Two reports have been prepared, but publication awaits the extension of the work to other trees. One factor of interest is that the density of timber from top logs has been shown to be approximately the same as from butt logs. These results indicate the possibility of the greater utilization of top logs which are generally left in the bush. Already one forest service is looking for better utilization in this direction, as a result of the work done.

8. *Timber Mechanics.*—The Section of Timber Mechanics was formed in October, 1931. The scope of its work covers a very wide field and on account of limited funds and staff it was decided to concentrate chiefly on box and crate testing as being one of the branches of work in which research is most urgently needed. Practically no previous scientific work has been carried out in Australia on container design and from the experience of other countries it is apparent that a vast improvement is capable of being made in the containers used in this country with immediate and substantial benefits to industry.

A special grant was obtained from the Rural Credits Development Fund of the Commonwealth Bank Board for the purpose of purchasing equipment for the work. With the aid of this grant a standard box-testing drum capable of testing containers up to 2 feet in length was constructed. In addition to the drum, a Denison 30,000 lb. Universal testing machine was obtained for the purpose of carrying out static loading tests on boxes and crates. This machine also enables such tests as nail-holding power of various timbers, efficiency of different types of nails, strength of strapping, &c., to be carried out.

A survey of the literature on the mechanical properties of Australian timbers has been made and a card index prepared giving full details of the available information. This work has revealed the great dearth of knowledge on the properties of many Australian species and the need for further research. In many cases, the results of the tests carried out are utterly valueless, no record having been kept of such important factors as moisture content.

As mentioned previously, the work of the Section was mainly centred on the testing of boxes and crates. Some idea of the importance of this work and the scope for possible savings may be gathered from the fact that 10,000,000 to 15,000,000 boxes of commodities such as butter, eggs, meat and fruit (fresh, dried and canned) are exported annually from Australia ; in addition to which over 50,000,000 containers per annum are required for the internal trade. It is estimated that £1,500,000 worth of timber per year is required for containers, and that short half of it is imported.

Striking evidence as to the need for considerable improvement in the design and construction of the containers used in Australia was furnished by visits to the wharfs and to the railways yards. In most cases the containers used for shipping goods by rail are quite inadequate to protect their contents from the normal handling they receive in transit.

The amount of money paid in compensation for damage to goods that were inadequately protected is no small item in the railways deficit.

The containers used for shipping goods overseas are, on the whole, fairly well constructed, but the design is often bad, and in many cases there is a pressing need for improvement. For instance, in one consignment of dried fruit that was being exported to England over 50 per cent. of the boxes were damaged before loading. As these boxes would probably be handled something like ten times more before reaching the consumer, the condition of the boxes on arrival at their final destination can be imagined.

That the importance of proper design is being realized by the industry is indicated by the fact that, in the six months that this work has been in progress, nine firms have requested that tests should be carried out on boxes made or used by them.

A trade circular setting out the principles of box and crate design and the method of testing has been prepared and is now ready to be sent to the printer. This publication will meet a long-felt want as no previous information on the scientific design of containers has been published in Australia.

Considerable damage is done to dried fruits exported to London by the *Plodia* moth. One method of reducing this damage is the use of a box which will remain insect-proof under the ordinary hazards of transport. This has been effected and a trial shipment of fruit is now on its way to London. A very simple alteration in the nailing schedule proved to be the key to the situation.

Other tests on an insect proof envelope provided by Dr. Munro of the Imperial College of Science and Technology showed that it has very great promise and it also is being tested in the experimental shipment.

It seems quite likely that clean fruit sent from Australia will reach the English market in good condition provided that proper precautions are taken in making the case.

The work on box design has led to several firms testing out hardwood cases to replace those made of imported softwood.

9. *Wood Chemistry.*—The work in this Section is directed to a study of the chemistry of Australian timbers. This involves the collection of an enormous amount of data from many samples of each of hundreds of species. The work is likely to be of considerable importance as chemical methods of utilizing wood are extended in Australia. The manufacture of paper, artificial silk, lacquers, &c., must sometime be established here and the data now being collected will then prove of the greatest value.

Chemical methods of identification of timbers, which are very hard to distinguish by other methods, have been developed. This work is progressing and without doubt will give results which will afford quick and simple methods for the solution of many problems of identification which frequently arise.

A further study is that of the chemistry of the timbers which are naturally resistant to white ants and rots. The object of this work is to find a type of wood preservative approaching that of the natural material. At present the wood of the turpentine tree of New South Wales is being systematically studied. This timber has proved to be the most resistant to the marine borers (*Teredo*) which cause such serious economic loss in Australia.

10. *Seasoning.*—This Section continues to expand its activities rapidly and great difficulty is experienced in meeting the numerous demands for assistance.

It is interesting to note the growth of kiln seasoning during the few years of the Division's activities. There are now in Australia 58 kiln installations with a total of 138 kilns. Of these, sixteen installations have been erected from designs supplied by the Division and several batteries are in course of erection. Several others have been erected to other designs, but in consultation with the Division. During the year, 23 sets of plans were provided to seventeen separate companies contemplating the erection of kilns.

During the year a third experimental kiln was erected. The three kilns are operating 24 hours a day on the development of drying schedules for various timbers, and they are booked up for months ahead. Timber producers are in this way saved costly and wasteful experiments,

and the Division is able to advise safe schedules on which kilns may be operated. Many requests are received for advice from all the States, but it has been unfortunately impossible except in a few cases to send an officer to the site of operations. Where possible, advice is given by correspondence, but where the cost of sending an officer is not prohibitive, this more satisfactory method is adopted.

The treatment of " collapsed " timber is probably of greater significance than any other phase of seasoning in so far as some of the most important Australian timbers are concerned. The method of treatment is not new, and has been in commercial use for some years, but there are several important aspects of it regarding which more information is needed. The most important of these is the question of stresses set up during the treatment. Although its importance has been recognized ever since the Section was started, it has only recently become possible to commence concentrated work on the project. Throughout the year, relevant observations were made in connexion with other projects, both in laboratory kiln work and in work at commercial plants, and these observations form a good foundation for the more intensive work just started. By bringing the reconditioning process into prominence, the Section has been largely responsible for its widespread adoption throughout Victoria and Tasmania.

Two types of electrical moisture meters have been designed in the United States of America, but as both are very expensive, it was planned to modify the design of one of these to make it more portable and reasonably cheap by restricting its range. A satisfactory design of what has been called a " Blinker Sorter " was completed. The instrument is readily portable and has proved most useful in rapidly testing moisture content in timber. A local manufacturer is now making these instruments and many are already in use. Numerous requests for others are being received and the timber trade has expressed great satisfaction at the development of this practical instrument.

As a result of the Division's work on the rapid drying of case stock, two firms installed kilns in Victoria and one in Tasmania. Hardwood case sides $\frac{5}{16}$ inch thick are being dried green off the saw in 36 hours and case ends $\frac{3}{4}$ inch thick in three days. This rapid drying is proving very helpful in the battle to establish the hardwood case in Australia instead of the imported softwood case. Proper seasoning is the secret of success in this development and rapid drying is essential for economic working.

11. *Wood Preservation.*—In December, 1930, a small experimental pressure cylinder and the necessary additional equipment were installed. Since its installation the plant has been used for determining the relative treatability of a number of species of Australian timbers and for laboratory tests on proposed wood preservatives. Numerous inquiries on the possibility of treatment, and the installation for test purposes, of sleepers have been more recently received. This has necessitated an extension of the original 4 ft. 6 in. long cylinder, and an additional 4 ft. 6 in. length has recently been completed to enable full sleeper lengths to be treated. The work of the Section has steadily progressed and is increasing in extent. In general the projects continue over a large number of years, more especially in the cases where field testing is made. The magnitude of this work is now becoming so large that unless provision is made for further scientific assistance, it will be impossible to accept new work. In the programme for 1931–32 provision was made for eighteen different projects excluding minor miscellaneous investigations. During the year it was necessary to add a further seven projects to the programme, and as a result it is impossible to devote the time necessary to particular projects. The number of inquiries has increased enormously, a total of over 200 having been received during the year. Visits were made to Western Australia, Sydney and Canberra (twice), and a total of 35 visits paid to factories.

A pamphlet on the preservative treatment of fence posts was issued, principally for the use of farmers. This was very well received and was re-published in full by the Western Australian Department of Agriculture in its Journal. It gives all the necessary details and costs for the cheap preservation of posts on the farm. The Wood Preservation Section acts in close co-operation with the Postmaster-General's Department, the Victorian State Electricity Commission, Melbourne and Metropolitan Tramways Board and Railways and Public Works Departments, and has in hand in conjunction with these bodies, numerous field tests of various methods of pole treatments. A large scale co-operative test has now been arranged and 325 poles will shortly be installed in two sites. A serious outbreak of rot in large stocks of wood blocks owned by the Tramways Board and the Melbourne City Council was investigated. Methods to overcome the trouble were devised and put into operation. The source of the infection was traced and steps taken to prevent its recurrence. This work has resulted in the saving of some millions of blocks and of a large sum of money.

There are numerous specifics against white ants and rots and a series of experiments is being carried out to test the efficacy of these.

An investigation of the durability of Australian timbers against termites is being carried out in co-operation with the Division of Economic Entomology. For the actual testing a co-operative working plan was prepared in conjunction with Mr. G. F. Hill, and the Division of Forest Products has commenced the collection of timber samples, a total of 40 species comprising 157 timber samples having been collected to date. Some preliminary work has also been commenced in standardizing field and laboratory tests. In the field tests matched specimens of three different species of timber has been placed around mounds of *C. lacteus* and *E. exitiosus*, the specimens being at different distances from the mound and different distances apart. The object is to determine the variation in attack around a mound and the influence of placement and aspect on attack, with the idea of developing a standard procedure. In the laboratory preliminary tests have been made on the effect of different humidities on the growth of the colonies and also on methods of handling termites and separating them from mound material so as to place the tests on a more strictly quantitative basis. Little information is available regarding termite ecology and there is a large field to investigate. Dr. F. G. Holdaway of the Division of Economic Entomology has been seconded for this investigation, and an intensive programme of work is planned on termite ecology for the coming year.

In addition, a number of less important investigations have been carried out, and together with the advisory work and the above series of projects, have constituted a very arduous programme for the small staff available. It is earnestly hoped that it will prove possible to give the necessary assistance to enable some of the fundamental researches to receive the fuller attention which they deserve. Future practical progress must depend upon the solution of the underlying problems.

X. COLD STORAGE INVESTIGATIONS.

1. *General.*—A survey of Australian industries engaged in the preservation and transport of perishable foodstuffs and, particularly, those employing refrigeration for such purposes, was carried out during the year 1931–32. It clearly revealed that, while fairly successful results have been obtained, largely by means of empirical observations and experience extending over many years, such methods have not always resulted in the elimination of wastage nor in success in the numerous details so essential for the marketing of produce of high standard quality. Data required to secure greater freedom from wastage, higher quality of the foodstuffs marketed and greater efficiency in the operations of the plants, can be obtained most readily and accurately by the application of scientific methods which naturally involve prolonged experimental work in a wide field, to include, more particularly, meat, fish and tropical and non-tropical fruit. There is increasing evidence to show that certain sections of the trade fully realize the part to be played by scientific research in expanding exports, and in developing new methods for the local marketing of foodstuffs.

Until the commencement of the present fiscal year, the Council's programme in this field was confined largely to isolated investigations, which, though yielding valuable data, were difficult to co-ordinate and did not adequately cover the field of urgent investigations required. While it had long been the intention of the Council to secure continuity and co-ordination of research work in the field of the preservation of foodstuffs, the lack of funds and trained scientific workers prevented the formation of a suitable organization. However, with the return to Australia of several investigators, who had been trained in England at such research centres as the Cambridge Low Temperature Research Station and the National Physical Laboratory, the Council established in August last a small Section of Food Preservation and Transport. One of the trainees, Dr. J. R. Vickery, was appointed Officer-in-Charge, and with two other trainees and two investigators previously engaged in isolated investigations in this field, the nucleus of a staff was formed which was adequate to study the most urgent problems and to continue the investigations previously undertaken by the Council. Associate-Professor W. J. Young of the Biochemistry Department, University of Melbourne, continued to act as the Council's Adviser in matters of food preservation and afforded the Section considerable help, not only by advice to the investigators, but also by serving on all the Committees set up to advise the Council in matters concerning meat and tropical and non-tropical fruit.

2. *Programme of Investigations.*—Shortly after the establishment of the Section, the Council's Adviser and the Officer-in-Charge drew up a programme of the most urgent investigations required. In addition to the work already in progress, viz., the maturation and transport of bananas and the treatment and storage of oranges, it was decided that, in view of the limited staff and facilities available, it would be advisable to concentrate initially on the following programme :—

(*a*) *Meat and Meat By-Products.*—(i) A study of the storage of beef at temperatures at or slightly above, the freezing point of the flesh, with a view to exporting it to England in a chilled condition.

(ii) A study of the freezing, storage and thawing of bacon pig carcasses with a view to placing them in the hands of the English bacon manufacturers in a condition most suited to the production of bacon and hams of high quality, and a subsidiary investigation to specify the type of fat suited to withstand successfully the storage, transport and curing processes.

(iii) An investigation designed to improve the texture and appearance of edible offal exported in the frozen condition from Australia.

(*b*) *Fruit.*—(i) Biochemical studies designed to determine the normal chemical composition of various varieties of apples, pears and oranges, and the relationships between chemical and physical constitution and storage lives, the investigations to begin with a study of the inorganic and organic phosphates.

(ii) A study of the breakdown in cold storage of the four chief varieties of apples exported from Victoria and Tasmania, the effects of the degree of maturity at picking, the optimum temperature, humidity and ventilation in storage, being studied.

(iii) Studies of the ripening of pears after storage under varying sets of conditions.

(iv) A study of the conditions of treatment and storage required for the successful export of whole passion fruit.

(*c*) *Transport and Engineering Problems.*—(i) Investigations, probably in association with Great Britain and New Zealand to secure more uniform physical conditions in ship's holds carrying chilled and frozen foodstuffs, particularly fruit.

(ii) Studies of physical conditions during the transport of tropical fruit from Queensland to the Southern States.

In order to carry out such a programme, fairly extensive laboratory facilities would obviously be required as close as possible to the chief sources of supply of the perishable foodstuffs to be studied. In the past the investigations were made possible through the generous provision of space in several University laboratories and by the granting of facilities by such institutions as the several Departments of Railways and the Victorian Government Cool Stores. For instance, the investigations on the maturation and transport of bananas were rendered possible by the granting of space in the Chemistry Department, University of Queensland, and the Biochemical Department, University of Melbourne, and through the many facilities provided by the Queensland Committee of Direction of Fruit Marketing and the Government Railways of New South Wales, Victoria and Queensland.

3. *Meat Investigations.*—As a result of a generous offer by the Queensland Meat Industry Board to provide and maintain a laboratory and experimental cold chambers at the Board's Abattoir, Cannon Hill, Brisbane, on condition that the Council supplied and maintained the necessary research officers, adequate facilities for a study of the storage and transport of meat were made available. The laboratories were designed by the Section's officers working in close co-operation with officers of the Queensland Meat Industry Board. Constructional work involved is now nearing completion, and the laboratories and experimental cold storage facilities will shortly be officially opened by the Minister in charge of the Council, Senator the Honorable A. J. McLachlan. The provision of the laboratories has been due, in large measure, to the far-sighted policy of the Chairman of the Queensland Meat Industry Board, M. E. F. Sunners, who has persistently advocated the need for organized research work on problems related to the meat industry.

A Queensland Food Preservation Research Committee, with Mr. Sunners as Chairman, has been appointed to afford advice to the Council on problems connected with the storage and transport of Queensland's perishable foodstuffs.

The problem of devising some suitable process by which beef can be exported in a chilled condition instead of frozen, as at present, is a matter of such outstanding importance that it has been decided to give precedence to the investigation of that problem.

Experiments at the Biochemistry Department, University of Melbourne, on the nature and causes of the " drip " which oozes from a cut surface of meat after freezing and thawing, have been concluded, and a full report will shortly be published. The investigations have shown that " drip " is similar in composition to juice which may be extracted from meat, by the use of low pressures, and that the conditions which promote a greater availability of low pressure juice also favour a greater percentage by weight of " drip ". The investigations, too, would seem to indicate that in meat the extent of the " drip " is independent of the rate of freezing, a result which may seriously affect projects for the rapid freezing of cuts of meat, since the efficacy of the method has usually been assumed to be dependent, in part at least, on the greater freedom from " drip " of rapidly frozen over slowly frozen pieces.

4. *Investigations on non-tropical Fruit Problems.*—Provision of laboratory and cold storage space for a study of the problems of the storage and transport of non-tropical fruit was made through an agreement between the Council and the Victorian Department of Agriculture. For some time past, the Department had been carrying out research work in this field in its experimental chambers at the Government Cool Stores, West Melbourne, and, with the pooling of the resources of the Council and the Department, more comprehensive experiments were planned by the Joint Advisory Committee on Fruit Preservation Investigations appointed by both bodies. Briefly, the agreement provided that the Department of Agriculture would supply the initial cold storage and laboratory facilities required, while the Council supplied the bulk of the new apparatus. Each body seconded an investigator to work jointly on the agreed programme, but each investigator was to remain responsible to his own organization. Investigations under the new arrangement were commenced in January last, and included studies of the storage of apples, pears and, later, passion fruit. As the Council's Citrus Preservation Committee was chiefly engaged in a study of the treatment and storage of oranges, the Council's agreement with the Department of Agriculture specifically excluded oranges from the sphere of the joint investigations. Towards the end of the present fiscal year, however, the Citrus Preservation Committee and the Joint Advisory Committee mutually agreed that projected investigations on the " sweating " or partial superfical desiccation of oranges could best be carried out under the auspices of the latter body.

Investigations commenced prior to the establishment of the Section of Food Preservation were actively continued throughout the year, and were again rendered possible by the generous provision of laboratory space by the Universities of Melbourne and Queensland.

5. *Treatment, Storage and Transport of Citrus Fruits.*—These investigations have again been carried out under the direction of Associate-Professor W. J. Young. A series of experiments on Navel oranges showed that too heavy a coating with paraffin wax, prior to storage, actually hastened breakdown of the fruit ; only a light coating, therefore, was indicated. A temperature of 38 degrees F. for storage, too, was found to be more satisfactory than one of 45 degrees F. An experiment on Valencia oranges, comparing the reactions in storage of fruit from various districts, yielded no clear-cut results. Treatment with paraffin had, however, an undoubted effect in checking browning of the skins.

The Council's Citrus Preservation Committee is now engaged in summing up the experiments carried out during the last four years with a view to determining whether the results of the washing processes, which have been tested, justify their commercial use.

Preliminary work by Dr. S. A. Trout on the chemical composition of Valencia oranges, and changes therein during storage, has been carried out at the Biochemistry Department, University of Melbourne.

6. *The Maturation and Transport of Bananas.*—The Council's Banana Maturation and Transport Committee, now re-constituted as the Fruit Preservation Research Sub-committee of the Queensland Food Preservation Research Committee, has concluded its experiments on the conditions necessary for the ripening of bananas. This work has been incorporated in the Council's Bulletin No. 64, which has recently been published. The Bulletin also contains instructions for successful commercial ripening as well as some advice on the construction of ripening rooms and on the instruments and appliances required. The published work also includes an interim report by Messrs. Holloway and Barr of the New South Wales Government Railways on the transport of bananas, as well as transport work in which the Council's investigators themselves took part.

It is gratifying to note that the results obtained by the Committee have begun to be applied by industry. In order to render aid in the commercial application of the conditions found by the Committee to be necessary for successful ripening, the Council willingly seconded to the Queensland Committee of Direction of Fruit Marketing, the services of one of its trained investigators, Mr. E. W. Hicks, who is now in charge of this body's ripening rooms in Sydney, the erection of which he supervised.

Since wastage in bananas due to " squirter " and " black-end " is still prevalent, more extensive experiments designed to study the causes of, and preventive measures for, these defects have recently been initiated, and both laboratory experiments and correlated transport investigations form part of the methods of attack.

7. *Problems of the Storage and Transport of Apples, Pears and Passionfruit.*—Since pre-storage factors subsequently influencing the nature and extent of breakdown of fruit in storage are so numerous, the most reliable methods of sampling of fruit in the orchards should be first ascertained when an extensive series of experiments in storage has been planned. The

initial investigations on the storage of apples carried out under the auspices of the Joint Advisory Committee have, therefore, been largely concerned with the size and nature of the standard sample ultimately to be employed. For these purposes, the Jonathan variety of apples was exclusively studied. Other investigations in the storage of apples have been concerned with :—

(*a*) The relationship between the maturity, picking and the development of radial water core in the Jonathan variety.

(*b*) The reliability of the existing commercial methods for the determination of the maturity of apples at picking.

(*c*) Bulk comparisons of the keeping qualities of apples from various districts of Victoria.

These investigations are still in progress.

Studies on the storage and ripening of pears, particularly the Williams variety, have shown the interesting result that following storage at low temperature (30 degrees to 37 degrees F.) there are certain optimum temperatures for ripening. For the Williams variety, a temperature of 65 degrees F. is desirable both for the development of maximum flavour and for the elimination of wastage during ripening. At temperatures of 45 degrees to 50 degrees F., the pears will not ripen. These results are believed to be of considerable importance to the canning industry which endeavours to extend the duration of processing of Williams pears by keeping large quantities in cold storage. In the past, however, ripening of pears after removal from cold storage was not always satisfactory. Other varieties, particularly the winter types, may be ripened at lower temperatures, but for the development of maximum flavour, a temperature of 55 degrees F. during ripening appears to be necessary.

With a view to studying the possibility of exporting passion fruit, experiments on the necessary pre-storage treatment and conditions of storage were commenced during the year. Although only preliminary data has been obtained, it would appear that the commercial storage life of passion fruit under all conditions is extremely limited in duration. It would appear, too, that the optimum temperature of storage is rather higher than that of all varieties of apples and pears. A method of wrapping for the control of crinkle, i.e., desiccation, has been obtained.

Recently the Joint Advisory Committee initiated experiments in the Council's new "sweating" chamber at the Victorian Government Cool Stores to determine the efficacy of various types of "sweating", or rapid partial, superficial desiccation of Navel oranges. "Sweating" of citrus fruit is frequently practised on a commercial scale, but no adequate tests of its usefulness have been carried out.

In particular, it was desired to ascertain whether "sweating" affected the commercial storage life by :—

(*a*) controlling fungal growth ;

(*b*) preventing fungal infection subsequent to treatment ;

(*c*) alteration of the longevity and quality (taste, &c.) in store.

These experiments are now in progress.

8. *Engineering and Transport Investigations.*—During the present year, the Section's engineer has been engaged almost wholly on the preparation of plans for, and supervision of, the erection of the Council's new laboratories in Melbourne and Brisbane.

9. *Miscellaneous.*—Many inquiries relating to the treatment and preservation of perishable foodstuffs have been dealt with during the year. The bulk of the inquiries have been concerned, however, with the rapid freezing of fish, and owing to the paucity of data available, some minor experimental work has been found necessary in order adequately to help the firms seeking information.

XI. OTHER INVESTIGATIONS.

1. *Commonwealth Prickly Pear Board.*—Owing to the general establishment of *Cactoblastis cactorum* throughout the prickly pear areas as a result of the intensive distribution conducted in the previous three years by the Queensland Prickly Pear Land Commission and the New South Wales Department of Agriculture in collaboration with the Commonwealth Prickly Pear Board, and to the huge natural increase of this insect, the large scale distribution work was not continued. However, 3,000,000 eggs in Queensland and 26,000,000 eggs in New South Wales were liberated.

Cactoblastis has continued to make remarkably rapid progress in the control of prickly pear, and enormous areas of dense primary pear collapsed from its attack during the year. So general has been this destruction that the great bulk of the primary pear throughout Queensland and the north-west districts of New South Wales has been brought to the ground. In the Upper Hunter district of New South Wales, where previously *Cactoblastis* had not progressed appreciably, in the past year it has made a definite advance, and the prospects of eventual control are more encouraging.

The destruction of the primary pear does not mean eradication of the pest. With the widespread collapse of the original dense pear and the consequent sudden reduction through starvation of the *Cactoblastis* population, a vigorous secondary growth has sprung up. In many districts this regrowth flourishes over large areas where the *Cactoblastis* infestation has not been sufficiently heavy to effect its check. However, it is satisfactory to record that *Cactoblastis* has regained the ascendancy in districts where the first heavy regrowth appeared early in the 1930–31 summer.

The occupancy and settlement of land cleared or mainly cleared of the prickly pear by biological means has been further advanced in Queensland. Ringbarking, clearing and fencing are being pushed forward, and already new settlers' homes have been erected on land which was covered with dense prickly pear four or five years ago.

The Prickly Pear Board's officers are paying particular attention to the following problems:—

(*a*) the control of regrowth;

(*b*) the destruction by insect enemies of hard or resistant types of prickly pear as exemplified in the Upper Hunter district; and

(*c*) the effect of pathological diseases and of native parasites on the progress of *Cactoblastis*.

The Board has two officers in South America engaged in the search for insect enemies of tiger-pear, *O. aurantiaca*. The North American investigations are still being continued, mainly with the object of introducing strains of cochineal and other insects for the purpose of bringing about the more rapid control of regrowth.

2. *Tobacco Investigations.*—As already stated in a previous part of this Report investigation into diseases of tobacco was continued during the year and results are being published as a bulletin and a pamphlet.

The general increase in production during the year was foreseen, and, with a view to minimizing the spread of blue mould, about 200 lb. of disease-free seed was purchased by the Commonwealth from the United States of America. It was treated by the Australian Tobacco Investigation and distributed on request to growers at landed cost price, and the seedlings were inspected during the growing season. No cases of introduced disease occurred. Blue mould gradually spread to the new plants (which were not resistant) from plants grown from domestic seed, from overwintering diseased tobacco plants of previous season or from wild hosts. Nevertheless the sum total of blue mould was much less than would have been the case as compared with previous years.

New growers and established growers were repeatedly advised through the press to grow only on the lighter sandy soils in suitable climatic areas, as otherwise the resultant crop would be heavy and dark coloured and unsuitable for the public taste. It may be noted here that another result of the seed distribution was the finding of areas in New South Wales and Victoria, where better quality tobacco can be produced. The greatly increased acreage grown and the quality of the crop make it clear that further stressing of this point is required, and the desirability of a publication on these lines is manifest.

The investigation was constantly asked for advice and while this was given when feasible, the growers were informed at the same time that they should keep in touch with thier respective State Departments of Agriculture.

In Queensland locality-test plots were laid down at Childers and Sunnybank and a number of areas, such as Harveston, Alton Downs, Pink Lily, Kepple Sands, Kinka, Silver Hill, Byfield, Yeppoon, Mackay (including Sarina), Miriam Vale, Bundaberg, Childers, Maryborough (Torbanlea), Sunnybank, Archerfield, Wowan, were reported on as to their suitability for tobacco culture. Fertilizer experiments on a comprehensive scale were laid down in Queensland at the Mareeba Experiment Station, at Sarina and at Bundaberg, and in Victoria at Wangaratta, and the tobacco therefrom will be tested for smoking quality in due course. At Wangaratta a battery of small

curing barns was erected and an investigation into curing processes was initiated. The result of one season's work cannot be regarded as conclusive, but an improvement in smoking quality of some of the leaf resulted from the slower process of fire curing.

Smoking tests are being conducted on 886 samples of tobacco from farmers' plots and on an approximately equal number from experiment plots. Samples are being collected from the present crop for smoking tests and it is planned to prepare a chart which will depict the results with a view to delimiting the areas suitable for tobacco culture.

A comprehensive report covering the operations of the investigations during the 1930–31 and 1931–32 seasons has been prepared and submitted to the Executive Committee of the Tobacco Investigation.

3. *Fuel Problems.*—In previous Annual Reports of the Council it has been pointed out that research in connexion with the production of liquid fuels from coal either by low temperature distillation or by hydrogenation, &c., involves not only the provision of complicated and expensive plant, but also the employment of highly qualified officers, and that large sums of money have been expended on such researches by public and private interests in various European and American countries. The Council accordingly decided that it would be undesirable for it to undertake research work in Australia on these problems and that its appropriate policy would be closely to watch the course of developments in other countries. Close liaison was, therefore, established and has been maintained between the Council and the British Department of Scientific and Industrial Research, and the Council is thus in the fortunate position of being kept in intimate touch, through the British Fuel Research Board, with all developments in the field of liquid fuel research.

Information regarding the present position of investigations on the production of fuel oil from coal was obtained by Dr. A. C. D. Rivett, the Chief Executive Officer of the Council, during a visit to Europe in 1930, and a report on the matter furnished by him was published as a Parliamentary Paper in 1931.* Dr. Rivett attached to his statement two reports prepared respectively by Dr. A. S. Fitzpatrick on "Costs in Liquid Fuel Production from Coal" and by Mr. L. J. Rogers on "The Production of Liquid Fuels from Coal". In his report he discussed separately the problems presented by black and brown coals under the following headings:—(*a*) Low temperature distillation of black coal; (*b*) hydrogenation of black coal; (*c*) low temperature distillation of brown coal; and (*d*) hydrogenation of (i) brown coal, (ii) brown coal tars. He expressed the opinion that the initiation and development of an Australian industry if practicable, could best be effected by some such organization as the then proposed association of international interests, and he considered it desirable that a close liaison should be established between the Commonwealth Government and these interests through their British member. Since the date of publication of Dr. Rivett's report the negotiations for the organization of international interests have led to the formation of the International Hydrogenation Patents Company of which the principal members are the Standard Interessen-Gemeinschaft Company (representing interests of the Standard Oil Company of America and the I.G. Farben-Industrie of Germany), the Royal Dutch Shell Group and Imperial Chemical Industries Ltd. As a result of Dr. Rivett's recommendation action has been taken by the Commonwealth Government with a view to the appointment of the Council as the liaison authority with the international organization through its British member, Imperial Chemical Industries Ltd.

Mr. L. J. Rogers, who left Australia in 1926 as a student under the Science and Industry Endowment Fund in order to undergo a course of training in research on fuel problems, has been employed since the termination of his studentship until August, 1932, by the British Fuel Research Board at its Research Station at Greenwich. Mr. Rogers is now returning to Australia and will be attached to the staff of the Council. He will thus be available to furnish authoritative advice on fuel research problems in Australia. For the present he will be occupied in inquiring into the various schemes concerning low temperature distillation of coal and oil-shale, the sponsors of which have approached the Commonwealth Government for assistance.

4. *Australian Radio Research Board.*—Investigations of the Board are of a fundamental nature and have for their immediate object the acquisition of knowledge of the propagation and characteristics of artificially and naturally generated electro-magnetic waves, with particular regard to those used in or affecting radio communication in Australia. The ultimate object of this work, of course, is the improvement of general radio practices throughout the Commonwealth, although it is inevitable that the information obtained by the Board will form an Australian contribution to the ever-increasing world-wide knowledge of this comparatively new branch of applied science.

* See Memorandum on the Present Position of Investigations on the Production of Fuel Oils from Coal, by A. C. D. Rivett, M.A., D.Sc., Parliament of the Commonwealth of Australia, No. 178, 1931. Government Printer, Canberra.

Originally, the work of the Board was along three main lines, namely, a survey of (i) field strengths, (ii) Heaviside Layer and fading work, and (iii) atmospherics. The field strength work, however, has now been completed (at any rate to a stage considered sufficient for the time being). It has thrown considerable light on the effect of various topographical features on the distribution of field strengths, and has enabled an assessment of the service provided to listeners over a wide area to be made. In addition to being of value in connexion with the most effective location of new transmitting stations, this information is also of value to manufacturers and set designers in that it gives such people a detailed knowledge of the sensitivity to which they should design sets intended for use in different localities.

As regards fading and Heaviside Layer work, observations at distances of 350 to 650 miles from the transmitting station have shown that two types of fading occur—(*a*) slow fading of a regular period ranging from 2 to 30 minutes, and (*b*) quick fading superposed on the slow fading and of smaller amplitude, but of more regular period. At shorter distances three types of regularity in fading were found—(*a*) slow fading of period one to five minutes and having an amplitude such that the signal intensity ranged from less than half the steady day value to almost double that value, (*b*) quick fading of period 5 to 30 seconds and of amplitude less than half that of slow fading, (*c*) periodic fading which appears most often in the period from one to two hours after sunset, is of remarkably pure sinoidal form, and has a larger amplitude than quick fading Work of this classificatory nature (the results of which are given in the Board's Report No. 4 published as the Council's Bulletin 63) is obviously of considerable importance from the point of view of the systematic development of means of mitigating the troublesome effects of fading.

The results of the studies of the heights of the Heaviside Layer at various times and of the polarization of skywaves after reflection from the Layer have been published as the Board's Reports Nos. 2 and 3 (issued as the Council's Bulletins 59 and 60). Special attention has been given to skywaves and to their reception on different types of aerials. As one result rather clear evidence of the lateral deviation of the skywave has been found—a possibility to which radio experimenters have given little attention in the past. Towards the end of the period under review, Professor Madsen and his staff were able to complete the erection of an experimental emitting station at the P. N. Russell School of Engineering in the University of Sydney. The transmitter is capable of delivering a power of about 1,000 watts into the aerial and has been specially designed for the Board's investigations. It is a source of gratification to know that on account of the ingenuity and co-operation of the authorities of the above-mentioned School in adapting various items of equipment this valuable transmitter has been erected at comparatively no cost to the Board.

The work on atmospherics was continued throughout the year, and the results to date have been written up as a report which will shortly be issued as the Board's Report No. 5 and the Council's Bulletin 68. Additional evidence has been obtained as to atmospherics affecting radio receivers having their origin in thunderstorms and cyclone disturbances. The value of the work for longer range weather forecasting than is possible by existing barometric methods and for following local storms in order to warn aircraft has thus been further substantiated.

5. *Mineragraphic Investigations.*—Of recent years the Australian gold and base metal mining industry has experienced a serious decline largely as the result of the exhaustion of many of the richer deposits of ore. The rehabilitation of the industry will thus involve, *inter alia*, the development of the lower grade but extensive deposits which are known to exist in various parts of the continent. This in its turn will involve the utmost efficiency in treatment methods. In the past, a difficulty that has always hampered the development of the best method of ore treatment has been the lack of information regarding the precise mineral content of the deposits. Ordinary assays of a complex ore are not enough. What is of greater importance is a knowledge of the precise minerals in the ore, the size of their individual crystals, and their association with each other, &c., because milling and ore dressing procedure are based primarily on the characteristics of the ore treated. A knowledge of the relation of the individual minerals to each other is also quite frequently of vital importance to the mining geologist, giving him information as to the genesis of the deposit, and thus leading to suggestions for the better development of the mine.

In the past, full information regarding mineral associations in a complex ore has been practically impossible to obtain because many valuable minerals occur in particles of microscopical size which are opaque to light and which cannot be indentified by the ordinary and well known petrographic methods. Of recent years, however, the difficulty has been largely overcome by the development of the use of the reflecting microscope together with special methods of identification. These methods are used by the Council's investigator, Dr. F. L. Stillwell.

During the year Dr. Stillwell has completed a study on the telluride ores of Kalgoorlie which has been published in the Proceedings of the Australasian Institute of Mining and Metallurgy N.S., No. 84, pp. 115–190. Telluride minerals are rare throughout the, world and the investigation of their remarkable occurrence at Kalgoorlie has contributed to our knowledge of these minerals, as well as making data available to those who are governing the new processes of ore treatment which promise to play an important part in the notable revival of activity at Kalgoorlie.

The field of mineragraphic investigations extends to the mineralogical examination of concentrates and residues and the installation of a small press during the past year for the mounting of specimens of these products in bakelite has proved very satisfactory. It has been applied to a number of mill products of the Wiluna mine, with results which confirmed the belief of the staff metallurgists that finer grinding would help to improve recoveries, and that some investigation into the roasting of concentrates, with a view towards better control, would probably be beneficial.

Investigations are in progress on ore from Mt Remus, Tasmania, in order to determine the source of the cobalt and vanadium in the ore, and also on the Read-Rosebery ores as a supplement to a geological survey recently carried out at Rosebery by the Geological Survey of Tasmania.

Dr Stillwell's services have also been used in connexion with surveys that have been undertaken with a view towards the encouragement of gold mining. In association with Mr. H. W. Gepp, Consultant on Development to the Commonwealth, and Mr. W. Baragwanath, Director of the Geological Survey of Victoria, an investigation has been conducted on the possibilities of gold-mining in the Castlemaine, Maldon and other areas of the main Bendigo district of Victoria.

The investigations carried out by Dr. Stillwell have been facilitated by a subsidy of £320 from the Australasian Institute of Mining and Metallurgy. The University of Melbourne has also assisted by granting the investigator laboratory accommodation at the Geology School.

6. *Standards Association of Australia.*—In the first Annual Report of the Council, attention was drawn to the fact that largely as a result of suggestions made by the British Economic Mission which visited Australia in 1928–29, steps had been taken for the re-organization of the Australian Engineering Standards Association and the Australian Association for Simplified Practice, which bodies had been combined under the title of the Standards Association of Australia. The Commonwealth Government decided that the Council should be the means of liaison between the Association and the Government. The year 1931–32 presented serious difficulties owing to the curtailment of contributions to the Association's funds from Governmental sources. Notwithstanding these difficulties, the work of the Association in all its major undertakings has been well maintained and, with promise of renewed support given by the Commonwealth Government and with the well-sustained contributions in funds and services from private enterprise, there is a prospect of an early movement towards recovery.

The tour of the Dominions undertaken by Mr. C. le Maistre, C.B.E., Director of the British Standards Institution, during the year has greatly stimulated interest in the efforts to achieve greater co-ordination between the standardizing bodies of the Empire, and strong hopes are entertained of definite action being taken in this direction as the result of discussions at the Imperial Economic Conference at Ottawa.

XII. MISCELLANEOUS.

1. *Publications of the Council.*—The following publications were issued by the Council during the year :—

(i) *Bulletins*—

No. 53.—The Flying Fox (*Pteropus*) in Australia by F. N. Ratcliffe, B.A.

No. 54.—Investigations on " Spotted Wilt " of Tomatoes—II., by J. G. Bald, B.Agr.Sc. and G. Samuel, M.Sc.

No. 55.—The Basal (Standard) Metabolism of Australian Merino Sheep, by E. W. Lines, B.Sc. and A. W. Peirce, B.Sc.

No. 56.—A Soil Survey of Blocks A, B, C, D and F, Rènmark Irrigation District, South Australia, by T. J. Marshall, B.Sc.Agr. and P. D. Hooper.

No. 57.—Infectious Entero-toxaemia (the so-called Braxy-like Disease) of Sheep in Western Australia, by H. W. Bennetts, D.V.Sc.

(i) *Bulletins*—continued.

No. 58.—The Life Cycle of Stephanurus dentatus Deising, 1839 : The Kidney Worm of Pigs, with observations on its Economic Importance in Australia and Suggestions for its Control, by I. Clunies Ross, D.V.Sc., and G. Kauzal, D.V.Sc.

No. 59.—Radio Research Board : Report No. 2—

(1) The State of Polarization of Skywaves, by A. L. Green, M.Sc.

(2) Height Measurements of the Heaviside Layer in the Early Morning, by A. L. Green, M.Sc.

No. 60.—Radio Research Board : Report No. 3—

(1) The Influence of the Earth's Magnetic Field on the Polarization of Skywaves by W. G. Baker, B.E., B.Sc., and A. L. Green, M.Sc.

No. 61.—Studies in the Supplementary Feeding of Merino Sheep for Wool Production—I. The Effect of a Supplementary Ration of Blood Meal on the Growth Rate and Wool Production of Merino Sheep on Central Queensland Pastures, by Hedley R. Marston.

No. 62.—A Soil Survey of the Cadell Irrigation Area and New Era, South Australia, by T. J. Marshall, B.Sc.Agr. and N. J. King, A.A.C.I.

No. 63.—Radio Research Board : Report No. 4—

(1) A Preliminary Investigation of Fading in New South Wales, by A. L. Green, M.Sc., and W. G. Baker, B.E., B.Sc.

(2) Studies of Fading in Victoria : A Preliminary Study of Fading Medium Wave Lengths at Short Distances, by R. O. Cherry, M.Sc., and D. F. Martyn, Ph.D., A.R.C.Sc.

No. 64.—The Ripening and Transport of Bananas in Australia, by W. J. Young, D.Sc., L. S. Bagster, D.Sc., E. W. Hicks, B.A., B.Sc., and F. E. Huelin, B.Sc.

(ii) *Pamphlets*—

No. 23.—Refrigeration Applied to the Preservation and Transport of Australian Foodstuffs. A Survey and a Scheme for Research, by J. R. Vickery, Ph.D.

No. 24.—The Preservative Treatment of Fence Posts (with particular reference to Western Australia), by J. E. Cummins, M.Sc.

No. 25.—Termites (White Ants) in South-eastern Australia. A Simple Method of Identification, by G. F. Hill.

No. 26.—The Irrigation of Horticultural Community Settlements. Notes for the Guidance of Advisory Boards in Murray Valley Settlements, by A. V. Lyon, M.Agr.Sc.

No. 27.—Zebu (Brahman) Cross Cattle and their Possibilities in North Australia, by R. B. Kelley, B.V.Sc.

No. 28.—The Pig Industry : Report on Conditions in Great Britain and America, with Suggestions Applicable to Australia, by R. B. Kelley, B.V.Sc.

No. 29.—The Possibility of the Entomological Control of St. John's Wort in Australia—Progress Report, by G. A. Currie, B.Sc., B.Agr.Sc., and S. Garthside, M.Sc.

No. 30.—The Bionomics and Economic Importance of *Thrips imaginis* Bagnall, with special Reference to its Effect on Apple Production in Australia, by J. W. Evans, M.A.

(iii) *Quarterly Journal*—

Vol. 4, No. 3, August, 1931.

Vol. 4, No. 4, November, 1931.

Vol. 5, No. 1, February, 1932.

Vol. 5, No. 2, May, 1932.

(iv) *Annual Report* for the year ending 30th June, 1931.

The confidential Monthly Summary is being issued as previously to members of the Council and of its State Committees as well as to members of the staff and students who are working in isolated positions or who have been sent overseas. This summary is also issued to certain research organizations in other parts of the Empire. In this last-mentioned direction it thus serves as one means of keeping these organizations acquainted with the various investigations, and to that extent plays its part in the general movement for the closer co-ordination of research work throughout the Empire as a whole.

2. *Catalogue of Scientific Periodicals.*—In the last Annual Report it was stated that a small Committee had been formed for the purpose of preparing and issuing Supplements to the Catalogue. Owing to a lack of funds and pressure of other work it has been found impossible to progress very far in the preparation of this Supplement. Entries showing the additions and amendments since the compilation of the original Catalogue have been prepared by many of the co-operating libraries. These have been sorted and placed in alphabetical order, and are available for consultation at the Council's Library. The work will be continued as opportunity offers.

3. *Library.*—The additions to the Library shelves at head-quarters during the last year have been 284, of which 190 consisted of bound volumes of periodicals. The number of bulletins, pamphlets, reports, &c., received has averaged 725 per month.

As explained in earlier reports, the head-quarters Library acts as a co-ordinating body for the divisional libraries. A catalogue of the books in all the divisional libraries is maintained there and a list of all additions is circulated among the staff each month. With the establishment of the Townsville Animal Health Research Laboratory and the Food Preservation Section in Brisbane, both of which have had to be equipped with literature appropriate to the work that they are doing, the Council now has in addition to the general scientific reference library in Melbourne six subsidiary libraries on special subjects in different parts of the Commonwealth which can be drawn upon when particular information is required.

4. *Bureau of Information.*—As in the previous years a great deal of information has been disseminated among the general public as a result of inquiries received personally or by letter. A few of the subjects on which information has been supplied are as follows :—

(i) *Agricultural and Horticultural.*—Banana by-products, peanut-growing, utilization of plane tree leaves, zamia palm eradication, oils from tea trees, poisoning of weeds, repellents for flies, sand drift, olive-growing, rice-growing, wild fire in tobacco, soya beans, manganese deficiency, blowfly repellents, Xanthorrhœa—methods for clearing, flax retting, black disease of walnuts, weevils in wheat, mineral feeding, cultivation of licorice, walnut cultivation, decomposition of rice bulbs for manure, blackberry eradication, ripening of malting barley, low grade raisins, tung oil, fertilizer from bones, guava control, beet sugar, stinkwort control, water hyacinth control, smoke screen for frost protection, ethylene oxide as a fumigant, *Melaleuca alternafolia,* wool grease, dingo baits, mint weed.

(ii) *Food Preservation.*—Orange juice, jams and preserves, sterilization of wine, canned desiccated coco-nut, pickles, dehydrating vegetables, potato chips, candied peel, lemon juice, cheese, cold storage problems, brine curing of beans, passion-fruit storage, lobster and whitebait canning, drying of rabbits, drying of fruit.

(iii) *Industrial Minerals, Chemicals, &c.*—Limestone, nicotine sulphate, cloudy ammonia, mica, felspar, carbon disulphide, tartrates, zinc oxide production, derris, pyrethrum extraction, fish refrigeration, salmon canning, guano analyses, micanite bentonite, cements for high temperature, manganese sulphate, vegetable black.

(iv) *Manufactures* —Artificial silk, caramel, malt, casein, glue, vinegar, cellophane, egg albumin, synthetic resin, tomato sauce, margarine, worcester sauce, eau de cologne, soap, boot polish, power alcohol from wheat, sawdust and sugar-cane, paper pulp from bagasse, paper from straw.

(v) *Miscellaneous.*—Anaphylactic properties of pollen, lubricating oil reclamation, silica bricks, industrial carbon, petroleum blending, utilization of celluloid waste, exploitation of sea shells, maize and edible oils, olive oil, activated carbon, patent rail, solid molasses, animal offal, producer gas, mechanical shelling of almonds, removing bitter skin from apricot kernels, power from windmills, shot gun cartridge wads, sanitary flooring with sawdust, patent wool pack, deoderization of animal fats, management of marine aquarium, dry cells, spontaneous combustion, water purification, anthrax from leather, reclaiming scrap tin, reclaiming scrap non-ferrous metals, cat gut, machines for testing abrasion, quinone in tanning, solder extraction.

XIII.—FINANCIAL MATTERS AND STAFF.

1. *Finance.*—The statement of expenditure from 1st July, 1931, to 30th June, 1932, is as follows :—

	£	£	£
1. Salaries and contingencies	..	..	*13,083
2. Remuneration of Chairman and Members of Council	..	..	†1,925
3. Investigations—			
(i) Animal problems—			
(*a*) Black disease, footrot, and preputial disease	1,940		
Less contributions from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England	652		
		1,288	
(*b*) Parasitology	4,464		
Less contribution from the Australian Pastoralists' Research Trust, the Empire Marketing Board, and McGarvie Smith Institute	1,214		
		3,250	
(*c*) Caseous lymphadenitis (New South Wales and Victoria)	1,091		
Less contribution from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England	190		
		901	
(*d*) Bovine Haematuria and Caseous lymphadenitis (South Australia)	..	916	
(*e*) Tick and tick fevers, pleuro pneumonia, &c.	4,694		
Less contribution from Queensland Government, Council of Agriculture, Brisbane, and the Empire Marketing Board, England	4,694		
		..	
(*f*) Entero-toxaemia (Braxy-like disease) Moora (gin gin) disease (Western Australia)	..	554	
(*g*) Pregnancy disease in ewes and pulpy kidney in lambs	698		
Less contributions from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England	698		
		..	
(*h*) Erection of McMaster Laboratory (final payment)	7,000		
Less instalments of donation of £20,000 made by F. D. McMaster, Esq.	7,000		
		..	
(*i*) Flying fox pest	40		
Less contributions from Governments of New South Wales and Queensland towards 1931–32 expenditure	40		
		..	

* The main items of expenditure under this heading are salaries of the Administrative Staff at the Council's Head Office; staff and upkeep of State Committees; part salary of clerk and typiste at Australia House; travelling expenses of head office staff, members of the Council, &c., and printing and general office expenditure.

† Provided from Consolidated Revenue Fund.

	£	£	£
(*j*) Cattle tick dips	212		
Less contributions from Governments of New South Wales and Queens and towards 1931–32 expenditure	212		
		..	
(*k*) Central office salaries, &c.	..	1,464	
(*l*) Miscellaneous	..	6	
			8,379
(ii) Plant Problems—Division of Plant Industry—			
(*a*) Central Laboratory— £			
Annual	4,073		
Capital 5,632			
Less contribution from Commonwealth Bank and Empire Marketing Board, England, towards erection of plant house 5,540			
	92		
		4,165	
(*b*) Experimental plots	1,011		
Less contributions from Empire Marketing Board, England	210		
		801	
(*c*) Plant pathology	1,744		
Less contributions from Empire Marketing Board, England ..	476		
		1,268	
(*d*) Plant genetics	2,322		
Less contributions from Empire Marketing Board, England ..	844		
		1,478	
(*e*) Plant introduction	..	1,062	
(*f*) Agrostology	787		
Less contributions from Empire Marketing Board, England ..	745		
		42	
(*g*) Plant physiology	496		
Less contributions from Empire Marketing Board, England ..	425		
		71	
(*h*) Noxious plants	..	349	
(*i*) Fruit problems	1,263		
Less contributions from Empire Marketing Board, England ..	408		
		855	
(*j*) Experimental Farm, Duntroon ..	..	474	
(*k*) Tomato wilt	..	541	
(*l*) Plant Introduction Garden, Gatton, Queensland	..	109	
(*m*) General botany	..	398	
			11,613
(ii) Entomological Problems—Division of Economic Entomology—			
(*a*) Central laboratory—	..	4,643	
(*b*) Noxious weeds	..	1,858	
(*c*) Blow-fly and buffalo-fly	..	7,031	
(*d* Orchard and fruit pests	..	461	
(*e*) Field crop and pasture pests ..	..	455	
(*f*) Forest insects	..	1,030	
		15,478	
Less contributions from Empire Marketing Board, England ..		4,991	
			10,487

	£	£	£
(iv) Animal Nutrition—Division of Animal Nutrition—			
(*a*) Central Laboratory—	5,955		
(*b*) Waite Institute	1,339	..	
(*c* Field Station, Beaufort, Victoria ..	95	..	
(*d*) Field Station, Young, New South Wales	97		
(*e*) Field Station, Moree, New South Wales	10	..	
(*f*) Field Station, Springsure, Queensland	327		
(*g*) Field Station, Mount Gambier, South Australia	117	..	
	7,940		
Less contributions from Commonwealth Bank (Rural Credits Development Fund) ..	3,000		
		4,940	
(*h*) Field Station, Kangaroo Island, South Australia	274		
Less contributions from the Australian Pastoralists' Research Trust and the Empire Marketing Board, England	274		
		..	
(*i*) Drought feeding experiments at Waite Agricultural Research Institute, Glen Osmond, South Australia ..	1,827		
Less contributions from the Australian Pastoralists' Research Trust, the Empire Marketing Board, and the Commonwealth Bank (Rural Credits Development Fund) ..	1,827		
		..	
At Waite Institute in co-operation with Empire Marketing Board and Adelaide University—			
(*j*) Mineral deficiencies in pastures		867	
			5,807
(v) Horticultural Problems of the Irrigation Settlements—			
Citricultural—			
(*a*) Research Station, Griffith—			
Salaries and incidentals	2,686		
Capital	64		
	2 750		
Less contributions by New South Wales Water Conservation and Irrigation Commission	1,200		
		1,550	
Viticultural—			
(*b*) Research Station, Merbein—			
Salaries and incidentals	3,345		
Capital	547		
	3,892		
Less contributions by Dried Fruits Control Board and Woorinen Dried Fruits Enquiry Committee ..	1,116		
		2,776*	
			4,326

* £796 was received for sale of produce and credited to Trust Fund receipts.

	£	£	£
(vi) Soil Problems—			
(*a*) Investigations at Waite Institute and Irrigation Areas—			
Salaries, &c.	4,138		
Capital	81		
		4,219	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)		2,500	
			1,719
(vii) Food Preservation and Transport—			
(*a*) Meat and Fish Investigations (Brisbane Abattoir)	1,095		
Less contribution by Queensland Meat Industry Board	69		
		1,026	
(*b*) Banana Investigations (Queensland University)		168	
(*c*) Non-tropical Fruits (Melb.)		611	
(*d*) Citrus Preservation	327		
Less contribution by Board of Trade	327		
		..	
(*e*) Engineering Problems		492	
(*f*) Adviser on Food Preservation		320	
		2,617	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)		2,617	..
(viii) Prickly Pear—			
(*a*) Grant for Investigations		4,500	
Less contributions from Commonwealth Bank (Rural Credits Development Fund)		4,500	..
(ix) Forest Products—			
(*a*) Central Laboratory—			
Annual	7,932		
Capital	1,574		
		9,506	
Less contributions—			
Commonwealth Bank (Rural Credits Development Fund)	2,559		
Hardwoods (Aust.) Pty. Ltd.	16		
Melbourne and Metropolitan Tramways Board	6		
		2,581	
			6,925
(x) Mining and Metallurgy—			
(*a*) Mineragraphic Investigations		709	
Less contribution by Australasian Institute of Mining and Metallurgy		336	
			373

	£	£	£
(xi) Radio Research—			
(*a*) Melbourne University	1,880		
(*b*) Sydney University	2,058		
(*c*) Adviser on Radio Research	101		
		4,039	
Less contributions by Postmaster-General's Department	3,029		
			1,010
(xii) Library	..	..	949
(xiii) Contributions to Imperial Agricultural Bureaux and to British Woollen and Worsted Association	..	..	3,125
(xiv) Miscellaneous—			
(*a*) Wood Taint in Butter Investigations ..	119		
Less contributions by Australian Dairy Council	119		
		..	
(*b*) Bee Investigations	339		
Less contributions from Commonwealth Bank (Rural Credits Development Fund) ..	339		
		..	
(*c*) Various	..	..	480
Total of Item 3—Investigations ..	..	..	55,193

2. *Contributions.*—The following statement shows the receipts and disbursements during the year of the funds provided by outside bodies and recorded in the special account established in 1931, entitled "The Specific Purposes Trust Account":—

	Receipts including balances brought forward from 1930–31.	Expenditure.
	£	£
Commonwealth Bank (Animal Health, Horticultural, Food Preservation and Transport, Prickly Pear and Forest Products Investigations)	15,000	14,117
Commonwealth Bank (Erection of Drought Feeding Building)	1,000	942
Commonwealth Bank (Erection of Plant House) ..	2,017	1,840
Commonwealth Bank (Bee Investigations)	500	339
Commonwealth Bank (Forest Products Investigations)	1,139	1,059
Empire Marketing Board, England (Erection of Plant House)	3,700	3,700
Empire Marketing Board, England (Entomological Investigations)	4,991	4,991
Empire Marketing Board, England (Plant Industry Investigations)	3,109	3,109
Empire Marketing Board, England (Animal Health and Animal Nutrition Investigations—Sheep Research)	2,092	2,092
Empire Marketing Board, England (Animal Health Investigations—Cattle Research)	2,484	2,347
F. D. McMaster, Esq. (Erection of McMaster Laboratory)	7,000	7,000
Postmaster-General's Department (Radio Research) ..	3,279	3,029
Australian Pastoralists Research Trust (Animal Health and Animal Nutrition Investigations—Sheep Research)	1,826	1,579
New South Wales Water Conservation and Irrigation Commission (Maintenance of Griffith Research Station)	1,200	1,200
Queensland Government (Animal Health Investigations—Cattle Research)	2,995	2,151
Carried forward ..	52,332	49,495

	Receipts including balances brought forward from 1930–31.	Expenditure.
	£	£
Brought forward ..	52,332	49,495
Council of Agriculture, Brisbane (Animal Health Investigations—Cattle Research)	300 ..	196
McGarvie Smith Institute (Animal Health Investigations)	250 ..	242
Australasian Institute of Mining and Metallurgy (Minerographic Investigations)	336 ..	336
Dried Fruits Control Board (Dried Fruits Investigations)	1,063 ..	1,060
Australian Dairy Council (Wood Taint in Butter Investigations)	200 ..	119
Australian Meat Industry Employees' Union (Food Preservation Investigations)	50 ..	..
Board of Trade (Storage and Transport of Citrus Fruit)	451 ..	327
Woorinen Dried Fruits Enquiry Committee (Dried Fruits Investigations)	64 ..	56
Hardwoods (Aust.) Pty. Ltd. (Forest Products Investigations)	16 ..	16
Melbourne and Metropolitan Tramways Board (Forest Products Investigations)	25 ..	5
Queensland Meat Industry Board (Food Preservation Investigations)	130 ..	69
Department of Agriculture, New South Wales (Cattle Tick Dip Investigations)	212 ..	212
Department of Agriculture, New South Wales (Flying Fox Investigation)	5 ..	5
Department of Agriculture, Queensland (Flying Fox Investigation)	35 ..	35
	55,469 ..	52,173

3. *Staff.*—The following is a list of the staff of the Council as at the 30th June, 1932. The list does not include typists, laboratory assistants and labourers, &c.

1. Head Office Staff.

Chief Executive Officer—A. C. D. Rivett, M.A., D.Sc., F.A.C.I.
Secretary—G. Lightfoot, M.A.
Assistant Secretary—G. A. Cook, M.Sc., B.M.E., A.A.C.I.
Chief Clerk and Accountant—H. P. Breen. L.I.C.A.
Library—
Librarian and Scientific Assistant—Miss E. Archer, M.Sc.
Assistant Librarian—Miss A. L. Kent.
Accounts, Staff, Stores—
M. G. Grace, L.I.C.A.
J. Derum.
D. J. Bryant.
Orders—
R. W. Constable.
Records—
P. Domec Carre.
H. T. Chadwick.
W. Gillespie.
Clerical Assistant to Chief Executive Officer—Miss A. Slattery, B.A.
Clerical Assistant to Chairman—Mrs. N. Roberts.
Local Secretary, Canberra—R. F. Williams.

2. Secretaries of State Committees.

New South Wales—
Mrs. N. Roberts, 906 Culwulla Chambers, Castlereagh-street, Sydney.
Victoria—
G. A. Cook, M.Sc., B.M.E., A.A.C.I., 314 Albert-street, East Melbourne.

Queensland—

Miss H. Todd, corner Ann and Edward streets, Brisbane.

South Australia—

J. Ward Walters, Division of Animal Nutrition, University of Adelaide.

Western Austra'ia—

L. W. Phillips, M.Sc., A.A.C.I., Box K766, General Post Office, Perth.

Tasmania—

F. J. Carter, Box 631B., General Post Office, Hobart.

3. Australia House, London.

Representative in Britain—F. L. McDougall, C.M.G. (part-time).

4. Division of Plant Industry.

At Canberra—

Chief—B. T. Dickson, B.A. (Queen's Can.), Ph.D. (Cornell).
Senior Plant Pathologist—H. R. Angell, B.Sc.Agr., (McGill), M.S. (Wis.) Ph.D. (Wis.)
Senior Plant Geneticist—J. R. A. McMillan, B.Sc.Agr. (Syd.), M.S. (Cornell).
Senior Plant Introduction Officer—A. McTaggart, B.S.A. (Toronto), M.S.A. (Cornell), Ph.D. (Cornell).
Assistant Botanist—C. Barnard, M.Sc. (Syd.).
Assistant Plant Pathologist—W. L. Geach, B.Sc. (Bristol).
Junior Plant Pathologist—Miss P. H. Jarrett, M.Sc.
Junior Plant Introduction Officer—W. Hartley, B.A. Dip. Agr. (Cantab.).
Junior Plant Geneticist—H. F. Smith, B.Sc. (Agr.), (Edin.), M.S.A. (Cornell).
Technical Assistant (Genetics)—J. A. Harris, B.Sc.Agr.
Technical Assistant (Genetics)—K. Loftus Hills, B.Agr.Sc.
Junior Botanist (Agrostological Investigations)—H. K. C. Mair, B.Sc.
Assistant Physiologist—J. Calvert, M.Sc. (Belfast), F.L.S.
Biometrician—Miss F. E. Allan, M.A., Dip. Ed.
Chemist—E. H. Kipps, B.Sc.
Assistant Botanist (Agrostological Investigations)—T. B. Paltridge, B.Sc.
Librarian (part-time)—Mrs. L. M. Willings, B.A.

At Waite Agricultural Research Institute, South Australia—

Assistant Plant Pathologist—J. G. Bald, B.Agr.Sc.

At Department of Agriculture, Western Australia—

Senior Plant Pathologist—W. M. Carne, F.L.S.

5. Division of Soil Research.

At Waite Agricultural Research Institute—

Chief—Professor J. A. Prescott, M.Sc., A.A.C.I. (part-time).
Soil Survey Officer—J. K. Taylor, M.Sc., M.Agr.Sc., B.A.
Assistant Field Officer—T. J. Marshall, B.Agr.Sc.
Assistant Chemist—H. G. Poole, M.Sc., A.A.C.I.
Assistant Chemist—J. S. Hosking, B.Sc.
Assistant Field Officer—P. D. Hooper.

At Commonwealth Research Station, Griffith—

Assistant Soil Chemist—H. N. England, B.Sc., A.A.C.I. (Seconded to New South Wales Water Conservation and Irrigation Commission as from 1st October, 1931).

Temporary Chemist—A. Howard, M.Sc. (from 18th December, 1931).

At University of Tasmania—

Assistant Soil Chemist—C. G. Stephens, B.Sc.

6. Irrigation Settlement Problems.

Commonwealth Research Station, Griffith—

Liaison Officer—F. K. Watson, M.A., B.Sc., A.M.Inst.C.E. (part-time).
Officer-in-Charge—E. S. West, B.Sc., M.S.
Accountant (part-time)—D. Chalmers.
Orchard Superintendent—B. H. Martin.
Field Assistant—E. F. Mackenzie, D.A. (to 13th February, 1932).
S. Smith-White, B.Sc.Agr. (from 4th April, 1932).
Clerical Assistant—Miss E. A. E. Smith, (to 16th April, 1932).
Miss E. Beck (from 21st March, 1932).

Commonwealth Research Station, Merbein—

Officer-in-Charge—A. V. Lyon, M.Agr.Sc.
Agricultural Officer—J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc.
Technical Assistant—D. V. Walters, B.Agr.Sc.
General Assistant—J. E. Giles.
Research Officer (part-time)—A. C. Ingerson.

7. Division of Animal Health.

At Head Office, Melbourne—

Acting Chief—J. A. Gilruth, D.V.Sc., M.R.C.V.S.

At Melbourne University Veterinary Research Institute—

Veterinary Officer—D. Murnane, B.V.Sc.
Technical Assistant—Miss C. Eales, B.Sc.

At Adelaide Hospital Pathological Laboratory—

Veterinary Officer—C. G. Dickinson, B.V.Sc.
Chemist—A. T. Dann, M.Sc.

Townsville (North Queensland) Cattle Research Station—

Officer-in Charge—A. W. Turner, D.Sc., D.V.Sc.
Veterinary Officer—J. Legg, D.V.Sc., M.R.C.V.S. (seconded from the Queensland Department of Agriculture and Stock).
Veterinary Field Officer—R. B. Kelley, B.V.Sc.
Assistant Bacteriologist—A. D. Campbell, B.V.Sc.
Clerical Assistant—Miss E. Horne.

At Department of Agriculture, Western Australia—

Veterinary Officer—H. W. Bennetts, D.V.Sc. (seconded from Department of Agriculture, Western Australia).

F. D. McMaster Animal Health Laboratory, University of Sydney—

Officer-in-Charge—I. Clunies Ross, D.V.Sc.
Haematologist—W. A. Carr Fraser, D.Sc., B.V.Sc.
Bacteriological Technician—E. Parrish.
Field Officer—N. P. Graham, B.V.Sc.
Assistant Parasitologist—G. Kauzal, D.V.Sc.
Assistant Veterinary Officer—W. I. B. Beveridge, B.V.Sc.
Clerical Assistant—Miss H. A. N. Turner, B.Arch.

8. Division of Animal Nutrition.

At the University of Adelaide—

Chief—Sir Charles J. Martin, Kt., C.M.G., M.B., D.Sc., F.R.S.
Senior Biological Officer—H. R. Marston.
Chief Assistant—J. Ward Walters.
Field Officer—E. W. Lines, B.Sc.
Chemist—R. G. Thomas, B.Sc.
Assistant—J. D. O. Wilson.
Assistant Chemist—J. W. H. Lugg.
Statistical Recorder—G. W. Bussell.
Chemical Assistant—F. C. Farr.
Assistant-Technician (Drought-Feeding)—H. Munz.

At Waite Agricultural Research Institute—

Assistant Field Officer—A. W. Peirce, B.Sc.
Agrostologist—A. B. Cashmore, B.Sc. (Agric.).

At "Buln Gherin" Sheep Station, Beaufort, Victoria—

Field Assistant—A. R. Beggs.

At "Meteor Downs" Sheep Station, Springsure, Queensland—

Field Assistant—C. Brown.

At "Wambanumba" Field Station, Young, New South Wales—

Field Assistant—R. Tout.

9. Mineral Deficiency of Pastures Investigation.

At the Waite Agricultural Research Institute—

Agronomist—K. M. Fraser, B.Agr.Sc.
Analytical Chemist—R. E. Shapter, A.A.C.I.

10. Division of Economic Entomology.

At Canberra—

Chief—R. J. Tillyard, M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.R.S.
Senior Entomologist—A. J. Nicholson, D.Sc.
Senior Entomologist—G. F. Hill.
Senior Systematic Entomologist—A. L. Tonnoir.
Senior Entomologist—I. M. Mackerras, B.Sc., M.B., Ch.M.
Senior Entomologist—G. A. Currie, B.Sc., B.Agr.Sc.
Entomologist—(Thrips Investigations)—J. W. Evans, B.A. (at Waite Institute from 22nd March, 1932).
Entomologist (Blowfly Investigations)—F. G. Holdaway, M.Sc., Ph.D.
Junior Entomologist—H. Willings, B.A.
Junior Entomologist—Miss M. Fuller, B.Sc.
Junior Entomologist (Blowfly Investigations)—Mrs. J. Mackerras, M.Sc., M.B.
Junior Systematic Entomologist—Miss W. P. Kent-Hughes, M.Sc.
Junior Systematic Entomologist—Miss L. F. Graham, B.A.
Field Assistant—T. Greaves.
Veterinary Officer (Sheep Blowfly Investigations)—C. R. Mulhearn, B.V.Sc.
Librarian—Mrs. L. M. Willings, B.A. (part-time).

At Farnham House Laboratory, England—

Entomologist—S. Garthside, B.Sc.Agr., M.Sc.

At Buitenzorg, Java, and Northern Australia—

Investigator (Buffalo-fly)—Professor E. Handschin.
Junior Entomologist—G. L. Windred, B.Agr.Sc.

In Northern Australia—

Junior Entomologist—T. G. Campbell.

In Western Australia—

Assistant Entomologist—H. Womersley.

At State College, Manhattan, Kansas, U.S.A.—

Junior Entomologist—S. G. Kelly, M.S. (Agr.).

11. Division of Forest Products.

At Head Office, Melbourne (temporarily)—

Chief—I. H. Boas, M.Sc., A.A.C.I.
Deputy Chief—S. A. Clarke, B.E., A.M.I.E. (Aust.).
Senior Chemist—W. E. Cohen, B.Sc., A.A.C.I.
Senior Seasoning Officer—C. S. Elliot, B.Sc.
Senior Preservation Officer—J. E. Cummins, B.Sc., M.S.(Wis.), A.A.C.I.
Senior Wood Anatomist—H. E. Dadswell, M.Sc.

At Head Office, Melbourne (temporarily).—continued.

Assistant Timber Testing Officer—I. Langlands, B.E.E.
Seasoning Officer—W. L. Greenhill, B.E., Dip.Sc.
Utilisation Officer—R. F. Turnbull, B.E.
Assistant Chemist—L. Badock, B.Sc. (to 28th May, 1932).
Temporary Chemist—A. G. Charles.
Assistant Chemist—A. B. Jamieson, M.Sc.
Assistant Wood Technologist—Miss M. D. Burnell, B.Sc.
Librarian and Records Clerk—Miss I. Hulme.
General Assistant—S. G. McNeil.
Assistant Seasoning Officer—A. J. Thomas, Dip.For. (seconded from Tasmanian Forestry Department).
Assistant Wood Anatomist (part time)—Miss A. M. Eckersley, B.Sc.

12. Cold Storage Investigations.

At Brisbane Abattoir—

Officer-in-Charge—J. R. Vickery, M.Sc., Ph.D.
Assistant Investigator—N. E. Holmes, B.E.E.
Assistant Biochemist—W. A. Empey, B.V.Sc.

At University of Melbourne—

Advisor and Investigator—Associate-Professor W. J. Young, D.Sc. (part-time).
Biochemist—S. A. Trout, M.Sc., Ph.D.
Biological Assistant—E. W. Hicks, B.Sc. (seconded to Committee of Direction of Fruit Marketing, Sydney, from 19th February 1932).

13. Radio Research.

At University of Melbourne—

Senior Investigator—G. H. Munro, M.Sc.
Investigator—R. O. Cherry, M.Sc.
Investigator—D. F. Martyn, B.Sc., Ph.D.

At University of Sydney—

Senior Investigator—A. L. Green, M.Sc., A.M.I.R.E.
Investigator—L. G. H. Huxley, M.A., Ph.D. (to 3rd September, 1931).

14. Other Investigations.

Mineragraphic Investigations—

Investigator—F. L. Stillwell, D.Sc.

Wood Taint in Butter Investigations—

Investigator—W. J. Wiley, M.Sc.

XIV.—ACKNOWLEDGMENTS.

The Council desires to acknowledge the very valuable assistance so freely afforded by many organizations and individuals. It is also desired to make special reference to the various State Departments, particularly those of Agriculture, and to the Universities. The help these bodies have given in affording laboratory accommodation and the use of their other facilities has been invaluable. Other organizations, including Commonwealth Departments and independent bodies, have also been particularly helpful. In addition to those who have been specified in the main part of this report, mention must also be made of many other private individuals who have taken a keen interest in the work of the Council and afforded it much help, both financial and otherwise.

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G. LIGHTFOOT, Secretary.

14th November, 1932.

APPENDIX.

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Professor H. A. Woodruff, M.R.C.V.S., &c.

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Printed and Published for the Government of the Commonwealth of Australia by
L. F. Johnston, Commonwealth Government Printer, Canberra.